Factors influencing residential rooftop solar PV purchasing decisions in an upmarket estate in South Africa

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A research report submitted to the Faculty of Commerce, Law and Management, University of the Witwatersrand, in partial fulfilment of the requirements for the degree of Master of Management in Energy Leadership

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SUMMARY

Residential and commercial electricity customers are plagued with rising electricity costs and declining supply availability, forcing them to seek alternative supplies. At the same time, South Africa has a favourable climate and is ranked as one of the countries with the highest solar resource potential in the world. The high solar resource capability and declining costs of residential rooftop solar PV systems make this a viable alternative for customers to minimise the impact of load shedding and rising electricity prices while reducing South Africa's carbon footprint.

This descriptive study aimed to understand the factors that influence customers in a residential estate in South Africa with Feed-In Tariffs to decide to adopt rooftop solar PV systems. Rogers' Diffusion of Innovations theory was used as the basis for the study, coupled with Moore's adaptation of Rogers' Diffusion of Innovations theory, which explains the gap between early adopters and late adopters of technology. A self-selecting quantitative study was conducted using all Midstream Estates residents as the population for the study. The results analysed using descriptive statistics and logistic regression analysis to determine the relationship between the dependent variable, adoption decision and the various independent variables.

The findings of the study are that personal circumstances such as gender, age, education status, occupation, income and household size were not determiners for adoption together with beliefs, however, attitude towards solar specially on economic benefits affected the adoption decision. Feed-in tariffs did not affect the adoption indicating that other factors were more important including power reliability which was found to increase the likelihood for adoption of residential rooftop solar PV systems.

KEY WORDS: Solar Power, PV adoption, Rooftop photovoltaic, Sustainable energy, Consumer Behaviour, Technology Adoption, Diffusion of innovation, consumer perceptions, Photovoltaic energy

DECLARATION

I, Lucky Mogashana, declare that this research report is my own work except as indicated in the references and acknowledgements. It is submitted in partial fulfilment of the requirements for the degree of Master of Management in Energy Leadership at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in this or any other university.

Name: Lucky Mogashana Signature:

Signed at Centurion

On the 28th day of February 2025

DEDICATION

This research is dedicated with profound love and gratitude to my mother, Mangakane Rachel Mogashana, who passed on at the end of my coursework as I embarked on this research journey. To my father, Ramahlodi Aaron Mogashana, who passed on in 2018, your lessons and teachings have shaped me into the person I am today.

I am deeply thankful to have had both of you as my parents and for the countless life lessons you bestowed upon me. Your wisdom and guidance have been the foundation of my values and character.

To my wife, Dr. Disa Mogashana (PhD), I am eternally grateful for the love, wisdom, and strength you imparted in me

I dedicate this research to all who remain students of life and embrace change. Your curiosity, resilience, and determination are a constant source of inspiration.

Most importantly, I give thanks to God for granting me the strength and faith to see this journey through to the end. Your divine guidance has been my unwavering companion, and for that, I am forever grateful.

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LIST OF ACRONYMS and ABBREVIATIONS

DMRE	Department of Minerals and Energy
DOI	Diffusion of Innovation
EAF	Energy Availability Factor
FIT	Feed-In Tariff
GHG	Greenhouse Gases
IBM	International Business Machines
IEA	International Energy Agency
IRP	Integrated Resource Plan
KM	Kilometre
LED	Light-emitting diode
LSM	Living Standards Measure
MES	Midstream Electrical Services
MYPD	Multi-Year Price Determination
NDC	Nationally Determined Contributions
NERSA	National Energy Regulator of South Africa
NPAs	Negotiated Pricing Agreements
OCGT	Open Cycle Gas Turbines
PV	Photovoltaic
REIPPP	Renewable Energy Independent Power Producers Programme
SALGA	South African Local Government Association
SAPVIA	The South African Photovoltaic Industry Association
SPSS	Statistical Package for Social Sciences
SSEG	Small-Scale Embedded Generation
STATS SA	Statistics South Africa
TAM	Technology Acceptance Model (TAM)
TBP	Theory of Planned Behaviour (TBP)
TRA	Theory of Reasoned Action (TRA)
UTAUT	Unified Theory of Acceptance and Use of Technology (UTAUT)

CHAPTER 1. INTRODUCTION

1.1 Purpose of the study

This descriptive study uses the diffusion of innovation technology adoption theory to evaluate factors influencing households' purchase of rooftop solar photovoltaics in an upmarket secure residential estate in Gauteng province, South Africa.

1.2 Context of the study

Energy is an essential driver for economic development and meeting basic human needs. It is produced and consumed in different forms, with electricity being one of them. Electricity is consumed in the industrial, residential, commercial, and agricultural sectors. Globally, coal-based electricity generation remains dominant at 38% and solar at 2% (Mampa & Alonge, 2021). According to the International Energy Agency, of the 229 TWh of electricity generated in South Africa in 2023, roughly 82% came from coal and 2% from solar (IEA, 2025).

The South African industrial sector consumes 58% of the total domestic electricity consumption of 180TWh (IEA, 2021). Second to the industrial sector, the residential sector consumes 22%, making the electricity supply in the residential sector just as important (IEA, 2021). Typically, South African households use 70% of the electricity supplied to them for cooking, heating and lighting (Department of Energy, 2019).

Eskom, a state-owned company, is the main supplier (about 90%) of electricity in South Africa (Eskom, 2021). As a shareholder, the South African government has mandated that Eskom supply electricity to all South Africans sustainably and efficiently (Steenkamp et al., 2016). The Eskom electricity generation fleet comprises thirty power stations with a total nominal capacity of 46.6GW, of which 38.8GW is coal-fired stations, 1.9GW is from Nuclear power, 2.7GW is pumped storage, 0.7GW is Hydro and Wind, and the remaining 2.4GW is generated from Open-Cycle Gas Turbines (OCGTs) (Eskom, 2021).

Most of the coal power stations are in the north-eastern part of the country. As a result, Eskom operates extensive distribution lines across the country to ensure supply to its residential and industrial customers with a distribution network capacity of roughly 400 000 KM (Eskom, 2021).

Eskom's inability to supply electricity consistently results from myriad of challenges; these include ageing infrastructure, operational challenges, poor maintenance regime, new built projects overrun, design flaws at new power stations, internal mismanagement and corruption (Mbomvu et al., 2021). The energy availability factor, which Eberhard and Mtepa (2003) define as a "*the percentage of maximum energy generation that a plant is capable of supplying to the electrical grid, limited only by planned and unplanned outages.*" has been declining since 2009, improved in 2015 but continued to decline since 2017 (Kock & Govender, 2021).

Since the dawn of democracy in 1994, the South African electrification program has focused on providing electricity to the previously marginalised, resulting in South Africa having one of the highest electrification rates in Sub-Saharan Africa (Bohlmann & Inglesi-Lotz, 2018). According to the World Bank data, South Africa's electrification rate is 85% overall, with the urban electrification at 87.9% and the rural at 79.2% (The World Bank, 2019). To achieve higher electrification rates, South Africa requires micro-grids and other decentralised energy solutions given the incremental costs of traditional distribution networks (Bohlmann & Inglesi-Lotz, 2018).

The challenges faced by Eskom and the increased electricity demand has led South Africa into a situation where at times supply does not match demand. Part of the mitigations by Eskom include the continuous operation of the peaking power plants, Open Gas Cycle Turbine (OGCT) to meet base demand instead of peak periods operations only. The OGCT plants utilise diesel fuel for electricity generation which adds additional operational costs to Eskom (Clark et al., 2022).

The mismatch in demand and supply has led to the implementation of loadshedding to ensure grid stability and prevent grid collapse, which impacts all sectors of the economy including residential customers (Mbomvu et al., 2021). Eskom started implementing loadshedding in 2007.

In its Integrated report, Eskom (2021) states its turnaround objectives focusing on operations recovery, improving their income statement, strengthening their balance sheet, implementing separation of the business, and focusing on their people (staff) and the culture of the organisation. These are seen as key enablers towards a functional Eskom, however, the implementation of the turnaround strategy has not been easy and will continue to be met with resistance in particular from labour (Andreoni et al., 2022).

Historically, South Africa had some of the lowest costs of electricity but there has been a rapid increase in electricity prices since 2008 (Thopil, 2021). The rising cost of electricity and the high dependence on electricity of households is putting a strain on the disposable income of households which in turn has a ripple effect on the economy (Goliger & Cassim, 2018).

The rising electricity prices combined with Eskom's inability to guarantee security of supply has resulted in households and businesses seeking alternatives (Thopil, 2021). In terms of regulations, embedded generation projects were limited to 1MW capacity without requiring a licence and this was recently increased to 100MW given the impact of loadshedding and the Eskom challenges to consistently meet supply (Richards & Stolp, 2021). This will enable more renewable projects.

It is globally accepted that there is a direct correlation between greenhouse gas emissions and the production and consumption of energy that is believed to influence climate change (Uhunamure & Shale, 2021). Society has awakened to the greater risk and threat of global warming and environmental degradation due to anthropogenic activities. This has led to multilateral agreements such as the Paris Agreement and the setting of Nationally Determined Contributions (NDC) capturing both the targets and commitments to the reduction of emissions to avoid reaching the 1.8 degree Celsius increase in temperatures post industrialisation (Mantlana et al., 2021). This is considered to be a catastrophic point and countries around the world are working to diversify their energy mixes through energy transition programs (Alrawi et al., 2022; Uhunamure & Shale, 2021).

Solar PV technology is considered one of the renewable energy solutions that has the potential to reduce emissions. Initially, the deployment of solar PV systems was constrained by high initial investment costs; but through technological advancement and massification of demand, the cost of Solar PV systems has been declining (Ebhota & Tabakov, 2022; Pandarum et al., 2019; Sewchurran et al., 2017). The increased availability of various Solar PV systems including battery storage is providing both industrial and household electricity customers with options to be partly off-grid, or fully off-grid.

1.3 Research problem

The global adoption of solar PV systems is driven by different factors, such as the environmental push toward emission reduction and decentralised electrification where grid access is unavailable. In South Africa, electricity is the backbone of household energy use, providing for essential needs such as cooking, heating, lighting, cooling, and appliance operation. National surveys show that households allocate more than 80% of their energy budgets to electricity, with only limited spending on other sources (Qeqe et al., 2022). However, Eskom’s ongoing supply challenges, together with the environmental impact of coal-based generation, are prompting many households to seek alternative, more reliable energy options. Residential rooftop solar PV systems present one such solution, helping to alleviate supply shortages while also reducing emissions.

Since 2022, the installation of Solar PV systems have been on the rise in the higher Living Standards Measure (LSM) groups, owing largely to affordability, availability, easy installation, environmental considerations and low maintenance costs. There is therefore a need to understand the intrinsic and extrinsic factors that motivate these LSM group into purchasing rooftop solar PV systems.

Previous research aimed to understand the factors that drive residents to embrace solar PV and the obstacles they face in doing so in order to comprehend the adoption of solar PV among residential consumers (Faiers & Neame, 2006). Uncertainty about household electricity savings, lack knowledge regarding solar PV technology, perceptions on the risk and complexity of technology were found to be some of the obstacles (Alipour et al., 2020; Faiers & Neame, 2006).

The shortage of review studies on residents' viewpoint regarding solar PV adoption in South Africa in the context of an upmarket residential estate with Small-Scale Embedded Generation (SSEG) scheme has resulted in gaps in research on what motivates residents living in such environments to install solar PV on their rooftops and the related technologies (Sommerfeld et al., 2017).

1.4 Research questions

In support of the research problem, the following research questions have been formulated.

1. What are the personal circumstances, beliefs and attitudes that motivate towards the adoption of residential rooftop solar PV systems?
2. To what extend does the small-scale embedded generation (SSEG) buy back tariff encourage or deter the purchasing of a residential rooftop solar PV system?
3. Has load shedding led to an increase in residential rooftop solar PV systems adoption?

1.5 Significance of the study

Internationally, there are studies focusing on drivers for investment into residential rooftop solar PV systems but given the different economic conditions with South Africa being an emerging economy and considering reliability of electricity supply in the country, the drivers may be different. Moreover, there is plenty of research focusing on commercial and industrial customers' drive towards rooftop solar PV installations, but the drivers are different for a commercial or industrial customer versus a residential customer.

This study aims to provide policy makers, municipalities, researchers, financial institutions, and solar PV service providers with insights into factors that influence the uptake of such systems. There may be insights for potential bespoke solutions to respond to the needs of potential customers in the residential rooftop solar PV.

1.6 Delimitations of the study

The study will focus on participants who have already invested and installed a residential rooftop solar PV system at their homes in the residential estate. The system is defined as any system that is either grid-tied or off-grid with an inverter, and thus the study excludes participants with residential solar geyser systems only.

1.7 Definition of terms

Loadshedding - defined as a controlled action undertaken to reduce the "strain placed on an electricity grid", by restricting electricity supply to customers in stages to limit the utilisation and protect the electricity grid from demand in excess of supply (Mbomvu et. Al 2021, Goldberg, 2015, Steenkamp et al. 2016)

Living Standards Measure (LSM) – is a multi-attribute assessment of household level access to services, durables and geographic indicators to measure the households stand of living (Wentzel et al., 2016). The households are classified from LSM 1 with LSM 10 having the highest standard of living and disposable income (Senatla et al., 2020).

Off-grid system / Stand-alone solar PV system. – is a system not connected to the main grid and uses the available irradiance to generate power for the connected load, charge batteries, when there is no solar energy, continue to power the load using the batteries (Mabunda, 2021). The system is characterised by its inability to export excess electricity generated.

1.8 Assumptions

Those who participate in the study do so of their own free will, with no expectation of study, they will share their perspectives, influences, and observations.

CHAPTER 2. LITERATURE REVIEW

2.1 Introduction

This chapter provides a review of relevant literature focusing on South Africa's state of residential household electricity supply, pricing and challenges. Furthermore, explores solar electricity supply globally and in South Africa. Then looks at Solar PV adoption behavioural theories and provides a summary take away from the literature review.

2.2 Electricity Supply in South Africa

The state owned utility company, Eskom, has been mandated with the provision of affordable and reliable electricity in South Africa (Department of Minerals and Energy, 1998). Currently, Eskom supplies roughly 90% of the country’s electricity demand the balance is supplied to Eskom by Independent Power Producers (Eskom, 2021; Thopil, 2021). Due to South Africa’s abundance of coal reserves, roughly 85% of the electricity is generated from coal-fired base-load power stations with Eskom operating a fleet of 15 coal-fired power stations (Eskom, 2021; Thopil, 2021).

Eskom is responsible for transmission and distribution of electricity to domestic and international customers through the South African Power purchasing pool scheme (Department of Energy, 2021; Eskom, 2021). The domestic distribution of electricity is either through Eskom to large direct customers or Eskom sales to municipalities who in turn on-sell the electricity to municipal customers as shown in Figure 1 (Department of Public Enterprises, 2019).

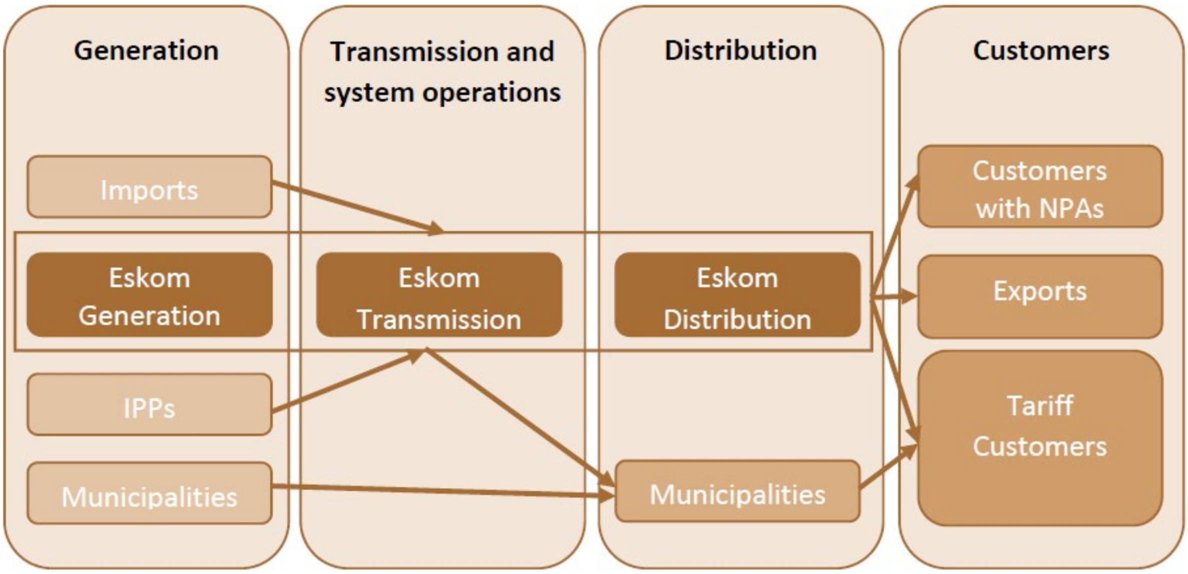

Figure 1: South Africa electricity supply (Department of Public Enterprises, 2019)

In recent years, Eskom has been plagued with various challenges ranging from leadership, operational, financial and governance which have led to the entity being unable to fulfil its core mandate of the provision of reliable and affordable electricity to all citizens (McKay & Hendricks, 2022; Nkosi & Govender, 2022; Thopil, 2021). In response to these challenges, Eskom has introduced measures to mitigate some of these challenges such as increasing the cost of electricity to customers and the introduction of loadshedding to minimise the potential grid failure (McKay & Hendricks, 2022; Nkosi & Govender, 2022; Thopil, 2021).

The impact of rising electricity costs and supply constraints on the economy, commercial and residential customers has been immense (McKay & Hendricks, 2022; Nkosi & Govender, 2022; Thopil, 2021). Government has also been concerned with the environmental impacts of the country's energy sector. On the back of the Integrated Resource Plan (IRP) and the white paper on energy, government began the process to introduce the Renewable Energy Independent Power Producers Programme (REIPPP), to increase the diversification of electricity generation in the country to include large scale alternative electricity generation such as Solar PV and Wind (Department of Minerals and Energy, 1998; Department of Public Enterprises, 2019; Eskom, 2021; Kritzinger & Meyer, 2015; Mabunda, 2021; Mantlana et al., 2021; Thopil, 2021).

In conjunction with the REIPPP, government has requested bids for emergency power producers in response to the high levels of lack of electricity supply, this programme is meant to provide relief in a short space of time and has seen government look to power ships, solar PV and wind projects. Additionally, government has relaxed the licencing requirements of projects with capacity less than 100MW which is a significant increase from the previous 1MW threshold.

Government has also introduced a tax break on purchasing of Solar panels by individuals to the limit of R15000 to encourage households to invest in rooftop solar PV and reduce the burden on Eskom (Department: National Treasury, 2023; Moodliar & Davidson, 2024; The Presidency Republic of South Africa, 2022). Despite all these interventions, Eskom's coal fleet power stations remain a huge challenge in maintaining and operating at optimal levels. There has been a decline in their Energy Availability Factor (EAF) as shown in Figure 2, which relates to maintenance and the plant’s capability loss factor (Kock & Govender, 2021). EAF is a good indicator of the system's ability to provide the required electricity.

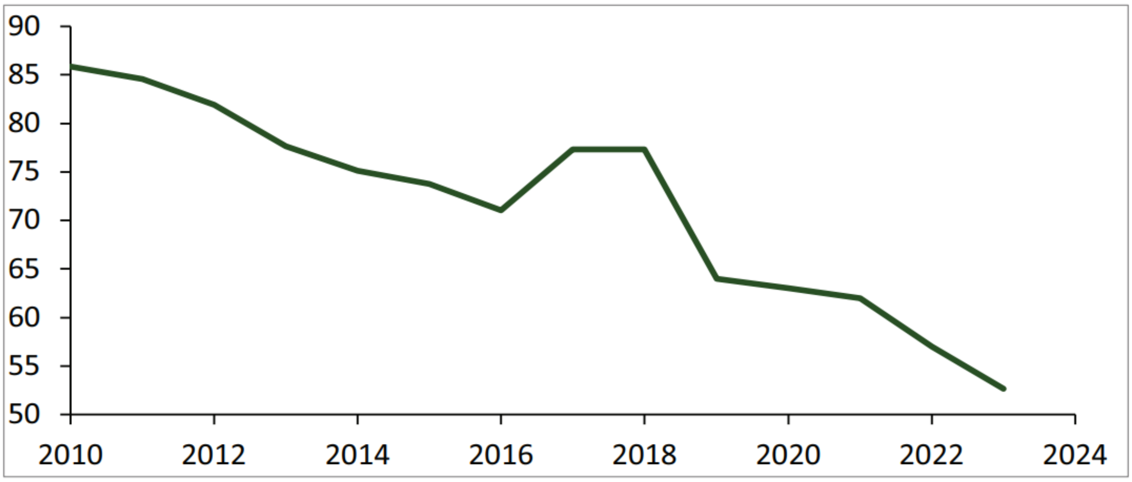

Figure 2: Eskom’s plant energy availability factor (EAF) trend 2010 – 2023 (Department of Minerals and Energy (DMRE), 2023)

The declining EAF is an indication of Eskom’s inability to meet the demand leading to frustrated customers, sluggish economic growth and a shift from centralised electricity generation to decentralisation for customers that can afford. Large customers are seeking alternatives and residential customers who can afford to reduce their dependence on grid electricity are opting to invest in the alternatives. These customers are also key to Eskom's and municipalities financial viability as they would ordinarily be the paying customers. Eskom has a debt burden due to municipalities and certain customers such as Soweto customers not paying to the value of R36.5bn (Bowman, 2020). The more paying customers seek alternative the more dire the situation will be for Eskom and municipalities who derive some of their revenue from electricity sales (Korsten et al., 2017; Kritzinger & Meyer, 2015; Sewchurran & Davidson, 2021).

A diversified electricity generation mix is required for South Africa which ensures that the intermittent renewables such as Wind and Solar PV which can be affected by weather are balanced with baseload electricity from sources such as Coal, Gas and Nuclear. The Department of Energy manages this process through its Integrated Resource Plan (IRP) (Boshoff, 2024).

Government has also started the process to unbundle Eskom into Generation, Transmission and Distribution entities which will be independent of each other (Department of Public Enterprises, 2019). The transmission entity will be responsible for sourcing supply from Eskom Generation entity and independent power producers then on selling to the Distribution entity which will sell to direct customers, municipal customers etc. Although the unbundling is in line with international convention where the Transmission entity is independent increase competition, in turn improving supply and creating a competitive pricing environment. The South African model, creates three government owned Eskom entities with similar governance structures, which some have criticised (Department of Public Enterprises, 2019; Richards, 2023; Ting & Byrne, 2020).

2.2.1 *Residential electricity supply*

Electricity supply in the residential area is the domain of Eskom and municipalities. In some parts of the country, electricity is supplied directly to residential customers by Eskom. While in some parts especially metropolitan municipalities, they tend to assume the function of electricity distribution to the residential sector.

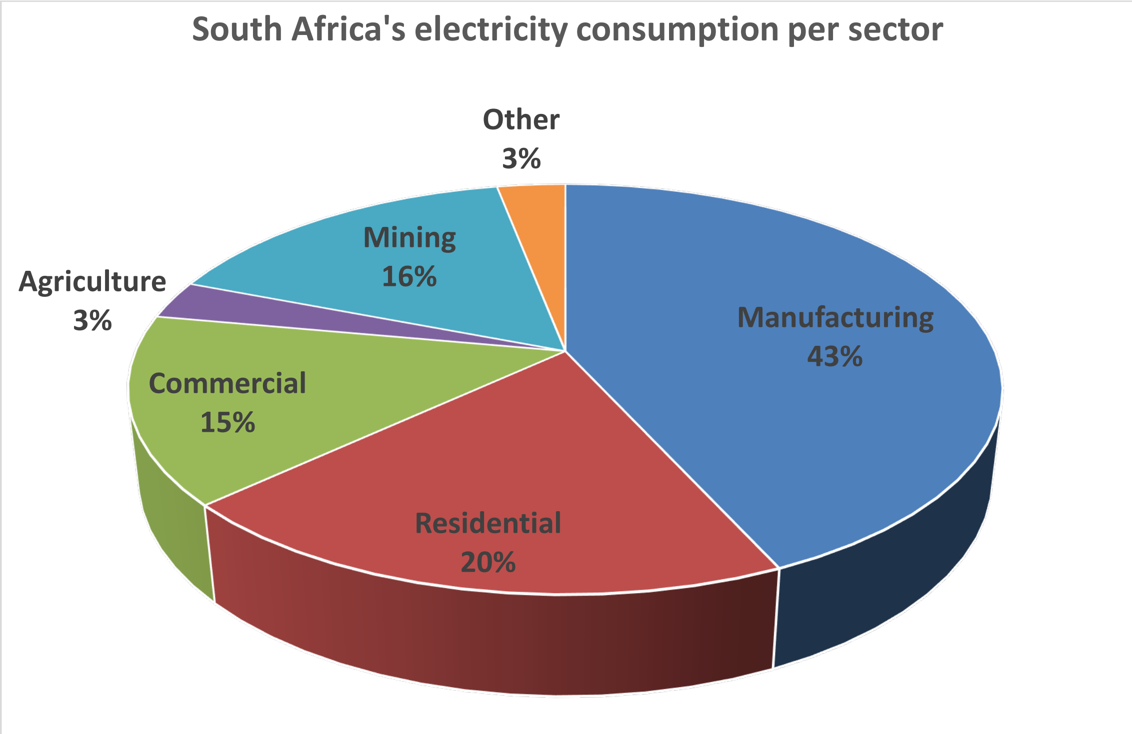

Figure 3: South Africa’s electricity consumption per sector (Department of Energy, 2021)

Figure 3 indicates that the residential sector accounts for 20% of the total electricity demand as electricity is mainly used for heating, cooking and lighting in this sector. The distinctive features of these sector is that it consumes mainly low voltage electricity but requires extensive distribution infrastructure as the customer base can be vast (Goliger & Cassim, 2018; Rix et al., 2015).

The average household consumption varies from urban to rural customers as their need for electrification differs significantly due to context (Mulaudzi et al., 2022). Urban residential customers tend to have higher average consumption as compared to rural customers, but urban customers also tend to have higher energy efficiency compared to rural customers. In terms of the residential electrification in line with South Africa's commitment to universal access to energy and the constitution of South Africa that recognises energy provision as a basic human right, the below depicts the electrification trend over the years (Thopil, 2021).

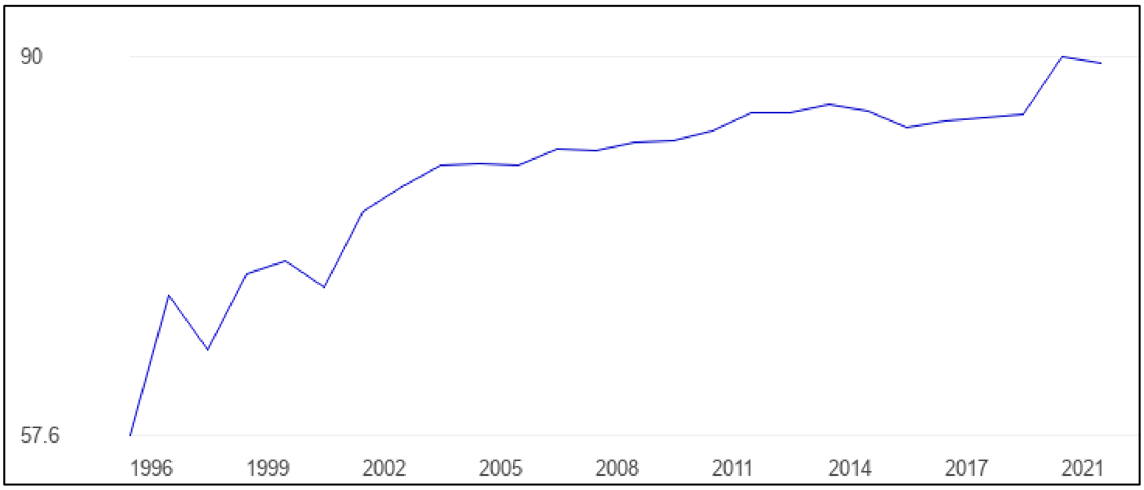

Figure 4: Access to electricity (% of population) - South Africa (The World Bank, 2023).

Roughly 90% of the population has access to electricity supply as indicated in Figure 4 and the remaining part of the population is mainly in the remote rural areas where the cost of laying the infrastructure far outweighs the benefits. But in the main the majority of South African's have access to electricity and are reliant on the provision of electricity from Eskom. The electricity supply to the residential customers is either prepaid or post-paid and follows various pricing structures that will be outlined below (Eskom, 2021).

Historically, Eskom maintained a surplus electricity supply, and government initiatives to extend electrification significantly increased household access to electricity. Consequently, residential consumers have become heavily reliant on Eskom, with the majority lacking alternative electricity sources during periods of supply unreliability. Generally, residential customers would await Eskom together with government to seek solutions to the supply challenges.

There has been various programs on the demand management side to reduce consumption and improve efficiencies such as the Solar-Water heater program, which also had incentives for households to switch their water heating to solar based (Goliger & Cassim, 2018; Thopil, 2021). In 2023, the government of the republic of South Africa announced a tax rebate for the purchase of solar panels in an effort to encourage households to seek alternative supply and reduce the demand on the national grid operated by Eskom. This rebate only applied to the acquisition of solar panels and did not cover the other essential components of a residential rooftop solar PV system such as the inverter and batteries, which are more expensive. The timing and magnitude of the rebate faced criticism, as it was believed that it will have little impact on the adoption of these alternatives. (Moodliar & Davidson, 2024).

2.2.2 *Electricity pricing*

Through National Energy Regulator of South Africa (NERSA), Eskom submits its MYP price application to the regulator, NERSA for review and approval (Eskom, 2017). The approved prices whether adjusted or not are then used as the basis for pricing to various customers, from commercial to direct residential customers and customers through municipalities. There are established tariff mechanisms in line with the energy policy and whitepaper, together with the act governing NERSA review process to ensure the both the consumer and Eskom are protected (Department of Minerals and Energy, 1998; Eskom, 2017).

Specific to residential customers, Eskom also publishes various tariff methodologies providing for various customers and seasons such as winter block tariff when overall demand is at its peak (Eskom, 2017). The greatest criticism to the pricing methodology is the fact that some of Eskom's inefficiencies in operations and projects ends up in the consumer paying for and thus does not place the accountability where it is due (Goliger & Cassim, 2018; Labuschagne, 2020; Thopil, 2021).

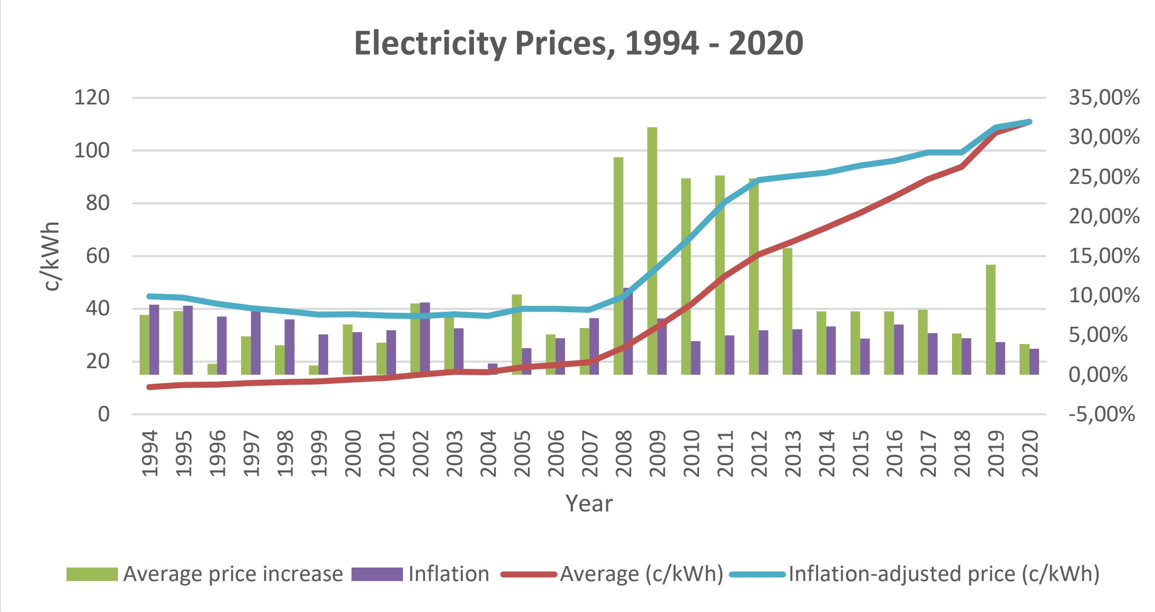

Figure 5: South Africa electricity costs 1994-2020 (Labuschagne, 2020)

South Africa was always seen to have the lowest cost of electricity for a long time but with the increased challenges, staff count at Eskom, municipalities subsiding other services through electricity sales and Eskom's response to poor project executions such as Medupi and Kusile resulting significant cost creep. *Figure 5* shows that the cost of electricity in South Africa has increased by 753% between 2007 and 2021, resulting in higher energy input and consequently cost of living (Goliger & Cassim, 2018; McKay & Hendricks, 2022).

2.2.3 *Impacts of loadshedding*

Residential households in South Africa are dealing with increasing electricity expenses and limitations in supply (McKay & Hendricks, 2022). Inadequate upkeep of Eskom's coal-fired power plants has led to frequent instances of load-shedding, as the demand for electricity exceeds its supply (Inglesi-Lotz, 2023). Eskom has mentioned that failure to implement scheduled load-shedding could lead to instability in the national power grid (Inglesi-Lotz, 2023).

In 2007/2008, South Africa experienced its first instance of loadshedding when Eskom's reserve margins, which represent the difference between available generation capacity and electricity demand, decreased to below 10% (Nkosi &

Govender, 2022). Load shedding is the reduction or interruption of an electricity supply to prevent excessive load on the power system, often occurring when generating units are taken offline for maintenance with a reserve margin of 8% or less (Inglesi-Lotz, 2023).

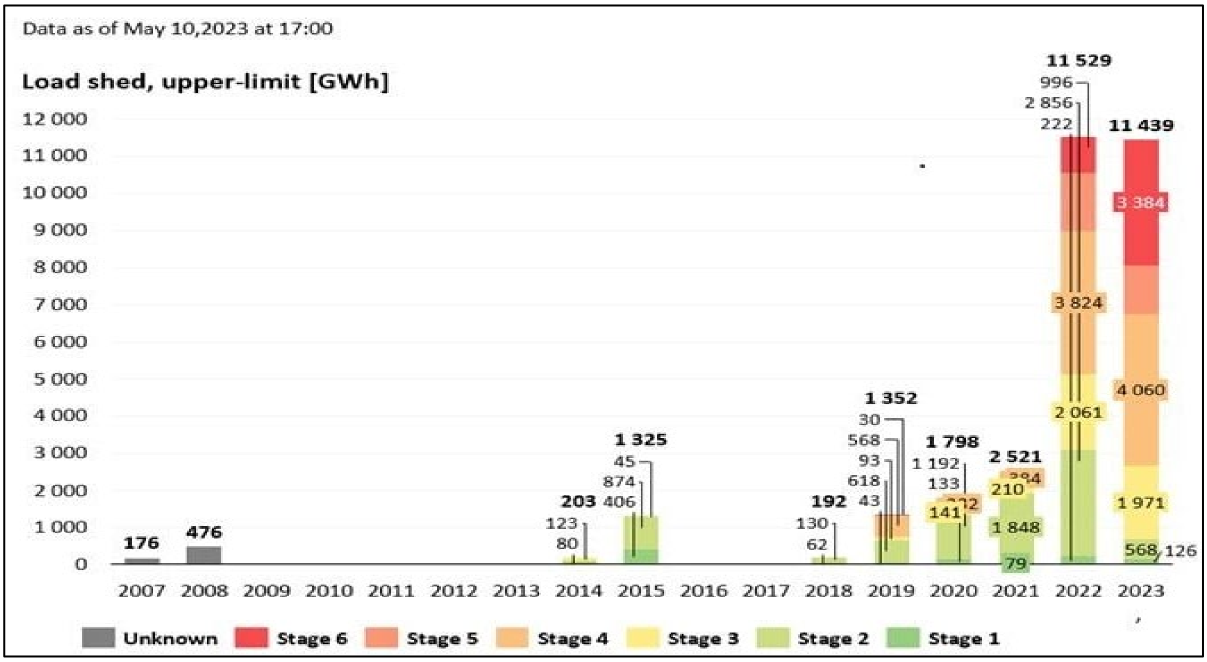

Figure 6: South Africa Load shedding statistics (Pierce & Le Roux, 2023)

Figure 6 shows that loadshedding increased between 2018 and 2023, with 2022 and 2023 recording the highest levels at approximately 11,500 GWh. The increasing loadshedding trend is largely driven by higher maintenance requirements for Eskom's ageing coal-fired power stations (Nkosi & Govender, 2022). The loadshedding is implemented in stages, with each stage, representing multiples of 1000MW of electricity demand that needs to be curtailed (Erero, 2023).

Power outages cause inconvenience in daily routines, food to spoil, and various other challenges. As a result, households resort to seeking alternative energy sources like diesel generators, solar PV systems, wood, and charcoal due (Inglesi-Lotz, 2023). Households occasionally choose to delay activities until power has been reinstated, which is the most economical choice but strains the grid due to a sudden surge in demand when electricity is restored (Inglesi-Lotz, 2023).

2.3 South Africa's solar potential

Solar photovoltaic technology, widely recognised as a way to produce electricity, utilises solar cells to transform solar energy into a stream of electrons (Singh, 2013). South Africa's long-term daily average of photovoltaic power potential ranges between 4.5 -6.4 kWh/kWp making the country to have one of the highest solar radiation levels worldwide, as can be seen in Figure 7 below. Most of the country has a high PV power potential, high solar intensity. The high potential indicates a high yield of energy as the kWh indicate how much electricity a system generates, while the kWp indicate how high its output is.

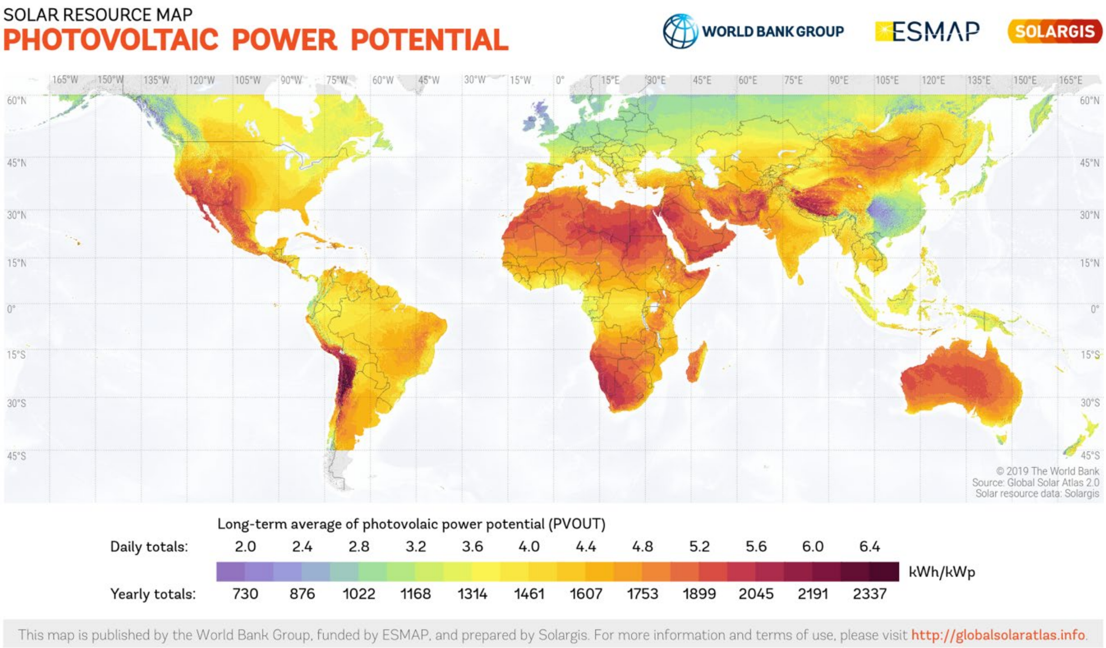

Figure 7: ESMAP. 2020. Global Photovoltaic Power Potential by Country. Washington, DC: World Bank.

Despite this high solar potential, South Africa has not fully exploited this natural resource and the implementation of solar PV as an energy source has not received broad support due to various factors such as perceived high initial costs, cheap coal in abundance and limitations to policy around renewables (McKay &

Hendricks, 2022; Mulaudzi et al., 2022; SALGA, 2023; Senatla et al., 2020; Sewchurran et al., 2017; The Presidency Republic of South Africa, 2022; Thopil, 2021; Ting & Byrne, 2020).

However, the increased energy insecurity and falling prices of rooftop solar PV systems globally has seen a significant increase in the importation of rooftop solar PV system components between 2022 and 2023 as shown in Figure 8 (McKay & Hendricks, 2022; Mulaudzi et al., 2022; SALGA, 2023).

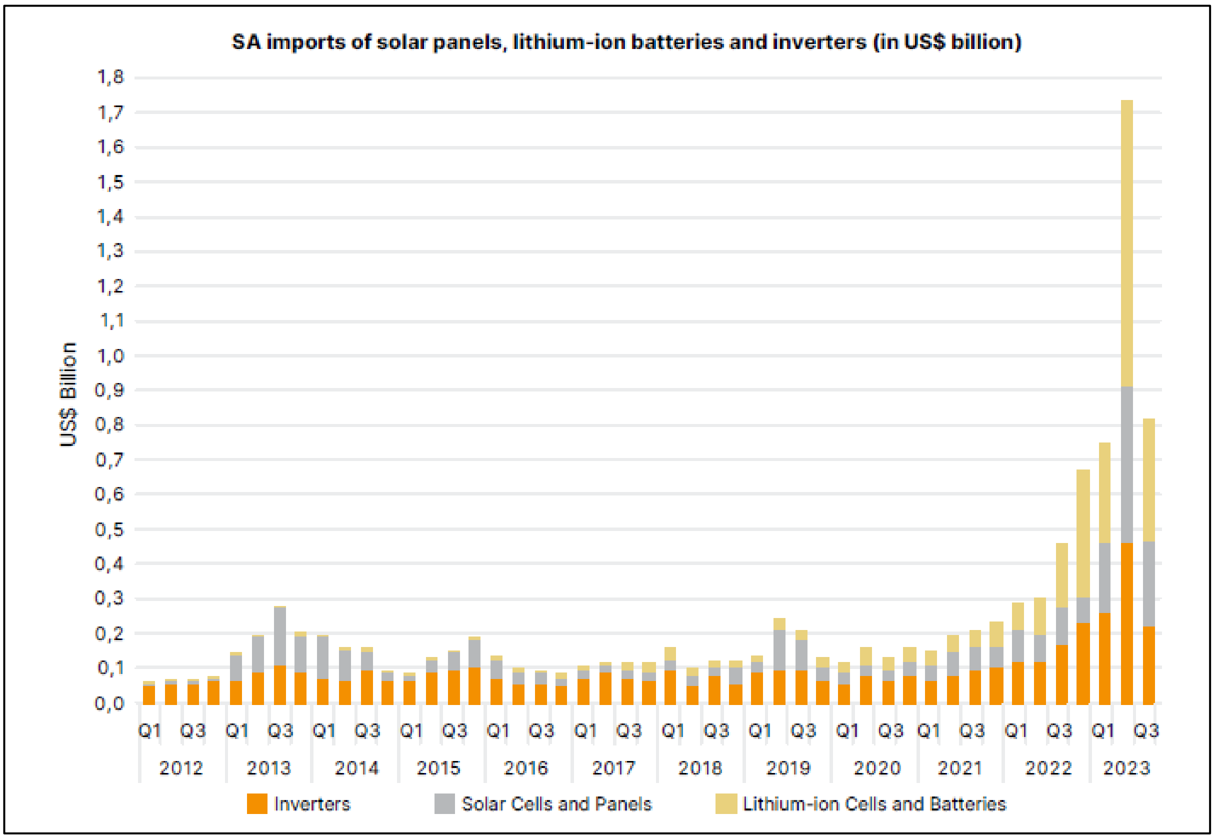

Figure 8: South Africa's import of solar panels, lithium-ion batteries and inverters (SALGA, 2023)

Household solar PV systems are typically rooftop mounted for better space utilisation. These residential rooftop solar photovoltaics systems are broadly defined as (Singh, 2013):

a) **Grid-connected solar PV** - is a power energised by PV modules that are connected to the utility grid.

b) **Off-grid solar PV** - is an electrical power system energised by PV modules, which are stand-alone and not connected to the utility grid.

Inverters, solar cells and panels, Lithium-ion cells and batteries are some of the major components that make up a solar pv system. These can be installed in various combinations.

2.4 Residential Rooftop Solar Systems

There are various residential rooftop solar PV systems varying from on-grid to off-grid; there are also hybrid systems. The systems can also be backup power systems.

The typical residential solar PV system will consist of an inverter, solar panels and a battery storage system. The common batteries are either Acid gel or Lithium batteries, with the later having different variations.

2.5 Small Scale Embedded Generation and Feed-In Tariffs

Residential rooftop solar PV systems fall under the Small-Scale Embedded Generation (SSEG) where the customer has the ability to generate some power for themselves. To maintain the stability of the grid, policies that govern SSEG are developed. These can be at national Government level, Eskom level or Municipal level. In South Africa, municipalities have developed SSEG policies to varying degrees. The residential rooftop solar PV systems typically have a system size of 0 – 30 kWp with an estimated installed capacity of 621 MWp by end of the first quarter of 2023 (SAPVIA dashboard).

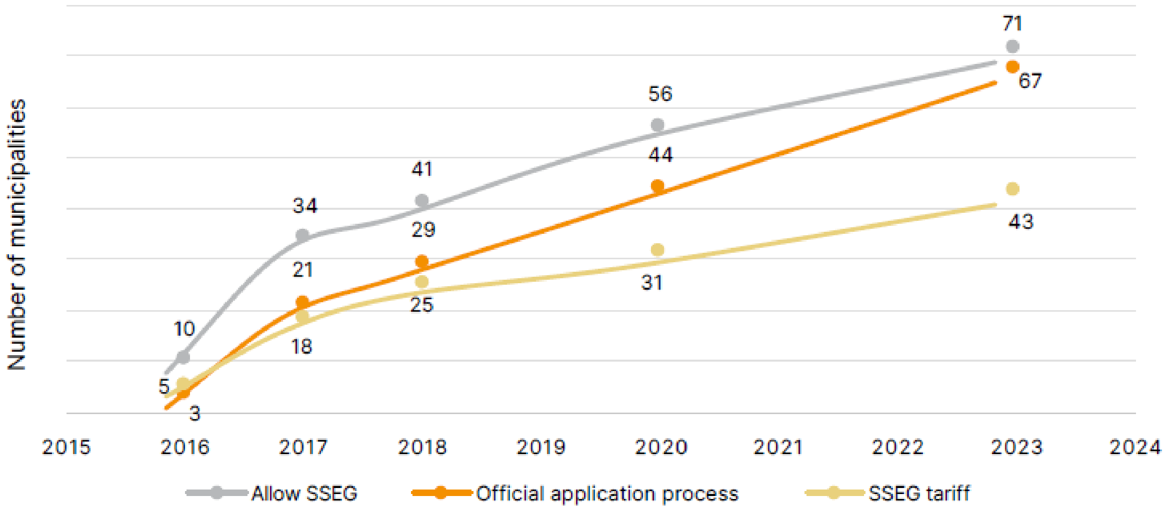

Figure 9: South Africa's municipalities SSEG program (SALGA, 2023)

Figure 9 indicates that of the 257 metropolitan, district and local municipalities 138 have taken up SSEG processes at various stages in 2023 either already allowing SSEG or have started the official application process to NERSA to allow SSEG (SALGA, 2023). There has been a rapid rise from 10 Municipalities that allowed SSEG in 2016 to 71 in 2023, and the number of municipalities with SSEG tariff but have not started the formal application process has rapidly risen from 3 in 2016 to 43 in 2023 paving a way for increased municipalities that will allow SSEG once they begin their application process.

Once SSEG is implemented by the municipalities or bulk electricity customers of Eskom who on sell the electricity to households, through their SSEG policies have to implement an SSEG tariff which will indicate all the associated costs of SSEG implementation (SALGA, 2023). Municipalities see SSEG implementation eroding their finances as typically they cross-subsidise from the revenues derived from electricity sales (Korsten et al., 2017; Kritzinger & Meyer, 2015; SALGA, 2023; Sewchurran & Davidson, 2021). The SSEG tariff also known as the Feed-In Tariff (FIT) takes into account fixed and variables charges and where bi-directional meters are not installed, the costs of adding such meters is borne by the customer (SALGA, 2023). The FIT is regulated by NERSA and published together with the municipal electricity tariffs on a regular basis.

When households connect their rooftop solar PV to the electricity grid under SSEG policies, grid management becomes essential as the consumer also becomes an active energy producer called a ‘prosumer’ (Alifia & Fraser, 2021). Smart grids are required to effectively manage the decentralisation of the energy market enabling the prosumer to actively manage their electricity generation and consumption with bi-directional meters and approved hybrid inverters.

In most cases, households’ consumption patterns do not match solar production and supply as such the systems remain grid-tied to allow for electricity purchase from the grid and also to sell excess electricity to the grid. Increasingly battery storage is included in systems to provide additional storage and mitigate against loadshedding and also utilise when there is no solar production (Eskom, 2017, 2023). The peak demand is not fully covered by the system and afternoon lull is created by the lower demand as supply from the solar PV lowers demand on the grid (Eskom, 2023).

Despite the current SSEG and FiT policies, there exists inhibitors to register or install residential rooftop solar PV driven by regulation requirements for (i) installed systems to be signed off by Engineering Council of South Africa (ECSA) registered professional engineer to issue Certificate of Compliance which is costly, (ii) the installation of bi-directional smart meters with high initial costs, (iii) High fixed charges included in the SSEG tariff for maintaining the grid and counter loss of revenue from reduced sales, these are not ideal for the consumer and (iv) Delays in approval of SSEG applications at municipalities slowing down the uptake of residential rooftop solar PV (SALGA, 2023).

2.6 The Technology Adoption Theory

The adoption of residential rooftop solar photovoltaic systems is a critical area of study in the field of sustainable energy (Chakraborty et al., 2018). Several adoption and diffusion theories have been developed and used across various fields to understand adoption behaviour (Alipour et al., 2021; Faiers & Neame, 2006; Fauzi et al., 2023).

These theories include the Diffusion of Innovation (DOI) theory, the theory of planned behaviour (TBP), the theory of reasoned action (TRA), the technology acceptance model (TAM), and the unified theory of acceptance and use of technology (UTAUT) (Alipour et al., 2021). Each of these offers valuable insights, but they differ in scope, complexity, and applicability to the context of solar PV adoption.

TAM and TPB, for example, focus on individual intention and perceived ease of use or behavioural control, which are useful but may not fully capture the broader social, economic, and infrastructural factors influencing household decisions in developing contexts (Alipour et al., 2021; Mahn et al., 2024). UTAUT attempts to integrate these theories, but its complexity and corporate or organizational focus make it less suitable for decentralized, residential energy technologies (Neves et al., 2025).

In contrast, Rogers's Diffusion of Innovations model offers a robust and widely applied framework for understanding how innovations spread in a social system (Awuku et al., 2023; Rogers, 2003). Its emphasis on five key attributes: relative advantage, compatibility, complexity, trialability, and observability; makes it particularly useful in explaining the adoption of technologies like solar PV, which are visible, costly, and influenced by peer networks and contextual fit (Alipour et al., 2021; Awuku et al., 2023; Fauzi et al., 2023).

Moreover, several recent studies (Menon & Sujatha, 2021; Pathania et al., 2017) have applied Rogers's model to solar PV adoption, allowing for comparability with existing literature. Given its proven relevance and adaptability to the residential rooftop PV context in developing countries (Awuku et al., 2023; Menon & Sujatha, 2021; Pathania et al., 2017), Rogers's model was selected as the most appropriate theoretical framework for this study.

2.6.1 *Rodger's Diffusion of Innovation theory (DOI)*

The theory of diffusion of innovations, developed by E.M. Rogers, explores how new ideas and technologies spread throughout a social system (Rogers, 2003). According to Rogers, the adoption of innovations is influenced by several characteristics perceived by individuals (Roux et al., 2021). This theory suggests that the adoption of innovations follows a predictable pattern, with individuals categorised into different adopter groups based on their willingness to try new things (Rogers, 2003).

Rogers presents the innovation-decision process and argues that the speed at which an adopter passes along this process is influenced by the attributes of the particular innovation and the propensity of the adopter to accept innovation. Adopters will systematically go through five phases in the innovation-decision process when determining whether or not to acquire an innovation illustrated in Figure 10.

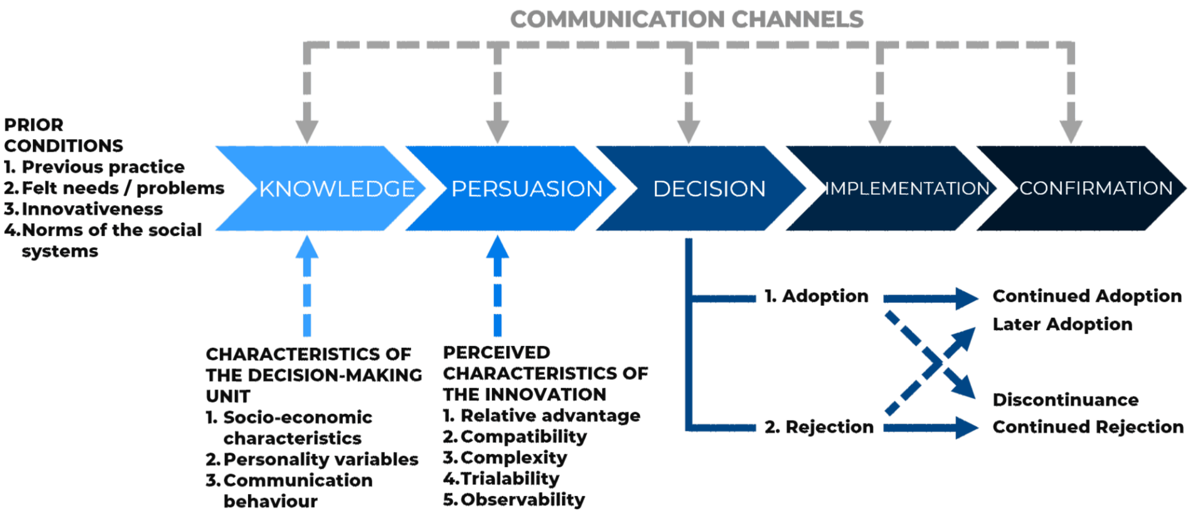

Figure 10: Rogers's theory of diffusion

In the knowledge stage, the adopter attempts to be knowledgeable about the innovation. At the persuasion stage, sometimes referred to as the 'awareness' stage, the adopter is concerned with the perceived characteristics of the innovation. At the decision stage, the adopter can either adopt or reject the innovation. In the implementation stage, the adopter chooses to proceed with the innovation. Lastly, in the confirmation stage, the adopter will confirm that the innovation meets expectations (Rogers, 2003).

The theory suggests that the adoption of innovations is influenced by characteristics such as relative advantage of the innovation, its compatibility with existing norms and values, its complexity or simplicity, trialability, and observability of its benefits (Rogers, 2003). The theory also recognises that the adoption of innovations is influenced by various factors, such as individual traits, social networks, and communication channels (Rogers, 2003).

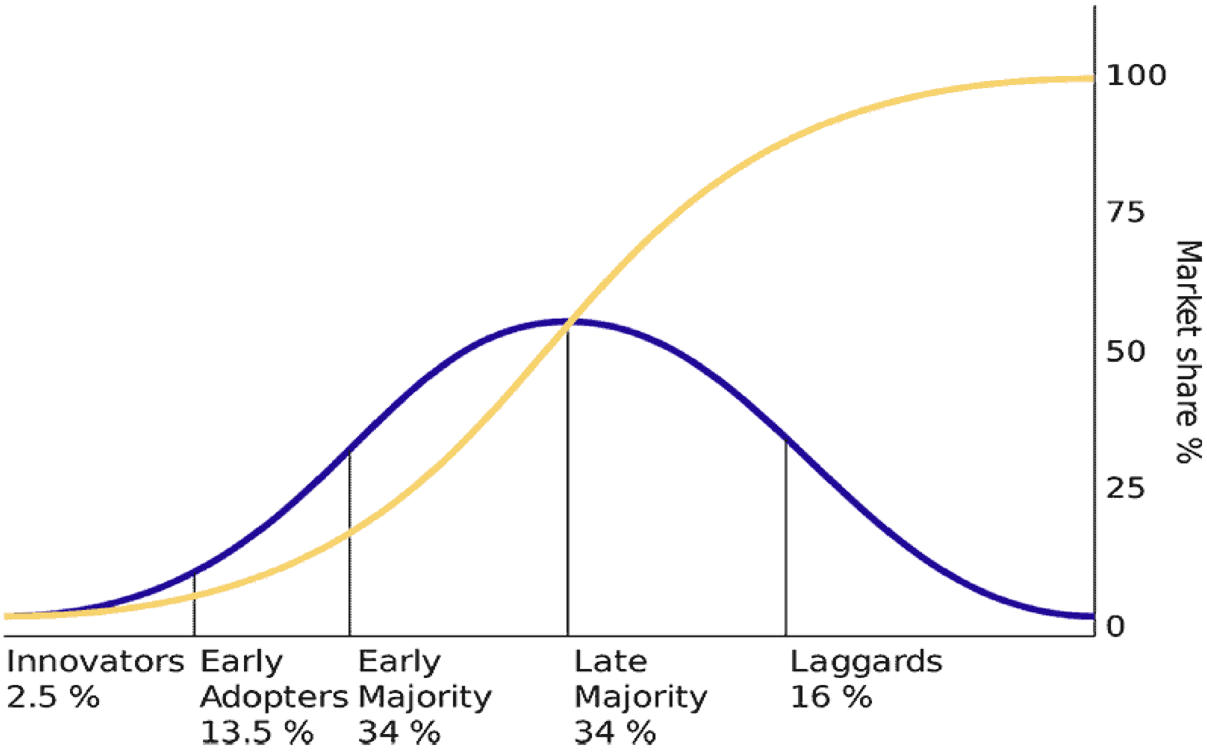

Figure 11: Technology Adoption Lifecycle and the S-Curve

The theory covers the adoption lifecycle, the adoption rate and the diffusion rate following an s-curve as shown in *Figure 11*. The adoption rate is the relative speed at which the members of a social system adopt an innovation (Rogers, 2003). In contrast, the diffusion rate of an innovation relates to the time it takes for an increasingly large number of members of a social system to start using the technology (Rogers, 2003).

The theory introduces five adopter categories to address the differences in adoption rate and diffusion rates among members of a social system (Rogers, 2003), namely:

1. The Innovators: These are the early adopters who have a keen interest in technical innovation and enjoy the technical aspects of energy systems.
2. The Early Adopters: These individuals are motivated by an interest in technical innovation and enjoy the technical aspects of energy systems, which drives their adoption of residential rooftop solar PV systems.
3. The Early Majority: These adopters are influenced by the positive experiences and recommendations of the early adopters.
4. The Late Majority: These adopters are more sceptical and tend to adopt new innovations after the majority have already adopted them.
5. The Laggards: These are the last individuals to adopt an innovation, usually due to resistance to change or a lack of awareness and understanding.

The DOI theory indicates that the distribution of these categories follows an S-curve shape of diffusion, indicating a normal distribution curve with half of the adopters in the early stages of the lifecycle (Rogers, 2003). Rogers argues that individuals who are innovators and early adopters exhibit traits such as having had more years of formal education and possessing a deeper understanding of the technology. Furthermore, the theory generalises adopters' socioeconomic status and innovativeness, indicating that this affects the adopters' technology adoption rate.

On the other hand, one argument opposing Rogers' diffusion of innovations theory is that it may oversimplify the complex process of technology adoption within a social system(Alipour et al., 2021; Faiers & Neame, 2006). Critics argue that the theory's categorisation of individuals into adopter groups based on their willingness to try new things overlooks the intricate and multifaceted reasons behind innovation adoption (Faiers & Neame, 2006). Additionally, the emphasis on characteristics such as relative advantage, compatibility, and observability may not fully account for the diverse motivations and barriers that individuals and communities face when considering the adoption of new ideas and technologies (Mutumbi et al., 2022; Simpson & Clifton, 2017).

Furthermore, some critics contend that the theory does not adequately address cultural and contextual factors that can significantly influence the adoption of innovations (Simpson & Clifton, 2017). It is argued that the diffusion of innovations is not solely determined by individual traits, but also by broader societal, economic, and political forces that shape the adoption landscape (Mutumbi et al., 2022; Simpson & Clifton, 2017). This criticism suggests that the theory's focus on individual and interpersonal factors may neglect the broader structural and systemic influences that play a crucial role in the adoption and spread of innovations within a social system.

Residential rooftop solar PV systems characteristics includes factors such as the perceived relative advantage, cost savings or environmental benefits; the compatibility of the technology with homeowners' lifestyles and values; the complexity or simplicity of the technology; and the observability, or the visibility of the technology to others (Faiers & Neame, 2006).

Overall, Rogers' diffusion of innovations theory provides a comprehensive framework for understanding the multifaceted nature of residential rooftop solar PV adoption. By examining the interplay of various factors, including individual perceptions, social dynamics, and external influences, researchers and policymakers can gain a deeper understanding of the complex process of innovation adoption in the context of solar energy (Mohandes et al., 2019).

2.7 Crossing the Chasm

Building on Rogers (2003) *Diffusion of Innovations* theory, Moore (2014) argues that there exists gaps between the different adopter groups influencing their adoption behaviour and emphasises that a bigger gap exists between the Early Adopters and the Early Majority as shown in *Figure 12*.

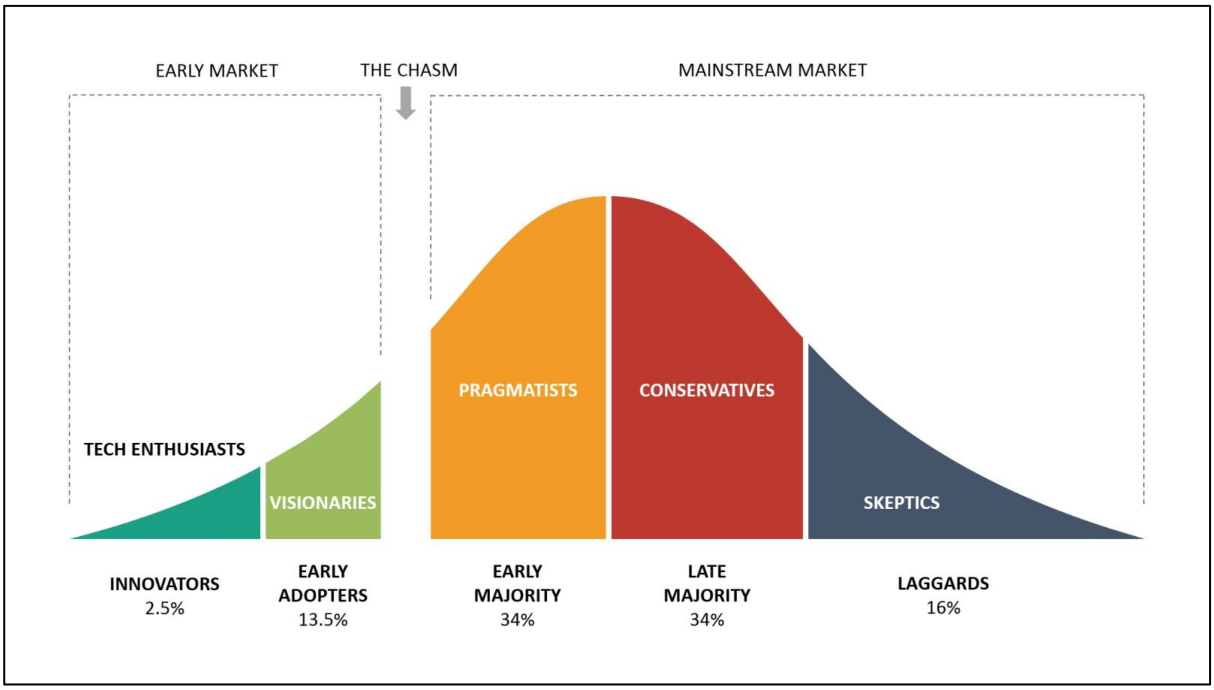

Figure 12: Technology Adoption Lifecycle adapted from Moore (2014)
Source: https://thinkinsights.net/strategy/crossing-the-chasm/

Moore (2014) highlights the chasm as the gap between the Early Adopters and the Early Majority. This gap exists mainly because the Early Majority is a representation of the start of mainstream adoption made up of mostly pragmatic customers. This group of customers is different from the Innovators and Early Adopters who are seen to be enthusiasts and visionaries (Moore, 2014; Rogers, 2003). In order for a product or technological innovation to achieve mainstream commercialisation, the chasm needs to be bridged.

The adoption rate of technology may be slow or never occur in the early majority if the technology lacks characteristics that appeal to this group (Palm, 2020). The early majority and the mainstream market seeks simple, cost-effective technology that solve their challenges (Moore, 2014). The rate of adoption of technology follows a bell curve which starts slowly with the innovators and early adopters then rapidly rises with the early majority , late majority and flattens out towards the end of the diffusion process with laggards (Rogers, 2003) however Moore (2014) highlights that the diffusion and adoption process does not happen as expected.

The mainstream market does not make its adoption decisions based on the novelty of the technology rather on the practicality of the technology. Moore (2014) suggests that to appeal to the early majority and enter mainstream market, a *whole product* built around the needs of a niche market has to be developed and marketed. The *whole product* has to provide a compelling reason for the target customer to invest in the technology, this implies that the technology must have recognisable quality, proven reliability of service and fit within a supporting infrastructure of products and systems to meet the customer needs holistically (Faiers & Neame, 2006; Moore, 2014).

2.8 Hypothesis

Given the literature review and research questions provided above, the following variables will be analysed in this study:

(i) Extraneous variables – the adopters' innovativeness,

(ii) Independent variable – the adopter's attitude towards rooftop solar PV systems, and

(iii) The dependent variable – The rate of adoption of the technology

Based on the above variables and literature review, the following hypotheses have been formulated:

2.8.1 *Hypothesis 1*

Rogers argues that the innovators and early adopters tend to have more formal years of education and a greater knowledge of the technology. Given the context of the study in an affluent estate, the argument can be put forward that the adopters are similar in socioeconomic status.

H1: There is no demographic, psychographic, and motivational difference between the Early Adopters and the Early Majority for the adoption of solar technology.

- Null Hypothesis (H_0): There is a significant demographic, psychographic, and motivational difference between the Early Adopters and the Early Majority.
- Alternative Hypothesis (H_1): There are no significant demographic, psychographic, and motivational differences between the Early Adopters and the Early Majority.

2.8.2 *Hypothesis 2*

While Feed-in tariffs are not nationally regulated in South Africa, they are implemented in certain parts of the country. They offer a form of payment for the electricity generated by solar PV systems, which can make the investment more attractive by ensuring a steady income stream. This financial incentive can lower the perceived economic barriers and increase the relative advantage of adopting solar PV systems.

H2: Feed-in tariffs significantly motivate the adoption of residential rooftop solar PV systems by providing financial incentives that enhance the perceived economic benefits and reduce the payback period for homeowners.

- Null Hypothesis (H_0): Feed-in tariffs do not significantly motivate the adoption of residential rooftop solar PV systems.

- Alternative Hypothesis (H_1): Feed-in tariffs significantly motivate the adoption of residential rooftop solar PV systems by providing financial incentives that enhance the perceived economic benefits and reduce the payback period for homeowners.

2.8.3 *Hypothesis 3*

Residential rooftop solar PV technology has been around for a while, but the rate of adoption is influenced by various factors. The acceleration in the adoption rate indicates the crossing of the chasm according to Moore's theory.

H3: A chasm exists between the Early Adopters and the Early Majority.

- Null Hypothesis (H_0): There is no chasm between the Early Adopters and the Early Majority.
- Alternative Hypothesis (H_1): There is a chasm between the Early Adopters and the Early Majority.

2.8.4 *Hypothesis 4*

The increase in load shedding is leading residential customers to become pragmatic about the residential solar PV technology solutions and bridging the chasm between the early adopters and the early majority. While residential solar PV systems might have been adopted early on by residential customers who were environmentally conscious, technology enthusiasts or innovative, the technology is now seen to solve a real and growing problem of lack of electricity supply. The early majority are seeking proven technology solutions that will address their electricity supply challenges.

H4: Frequent power outages due to loadshedding significantly accelerate the adoption of residential rooftop solar PV systems by enhancing the perceived relative advantage and compatibility of the technology, thereby facilitating the transition from early adopters to the early majority as described by Rogers' Diffusion of Innovations theory and Moore's Crossing the Chasm theory.

- Null Hypothesis (H_0): Frequent power outages due to loadshedding do not significantly accelerate the adoption of residential rooftop solar PV systems.

Alternative Hypothesis (H_1): Frequent power outages due to loadshedding significantly accelerate the adoption of residential rooftop solar PV systems by enhancing the perceived relative advantage and compatibility of the technology, thereby facilitating the transition from early adopters to the early majority.

2.9 Conclusion of Literature Review

While the government and various actors, including Eskom are working on mitigating the electricity supply crisis in the country, the IRP recognises the need for increased renewables including residential rooftop solar PV installations. This supported by declining costs of residential rooftop solar PV systems, increasing electricity tariffs and the high solar potential South Africa has, may drive increased residential adoption.

Rogers's diffusion of innovations theory provides a systematic process to evaluate the factors that can influence the adoption of residential rooftop solar PV systems, the theory although criticised for over-simplifying the adoption process, it is still the mostly used in this type of studies. Moore's extension of Rogers diffusion of innovation theory incorporates the concept of the chasm that exists between the early adopters and the early majority. If this is not mitigated, technology may never reach market maturity.

In this study, the hypothesis recognises the potential chasm and the likely bridge given the current state of electricity supply to residential households in South Africa.

Table 1. Consistency table: research questions and hypothesis

RQ #	Research Question	Hyp #	Hypothesis
1	What are the personal circumstances, beliefs and attitudes that motivate towards the adoption of residential rooftop solar PV systems?	1	There is no demographic, psychographic, and motivational difference between the Early Adopters and the Early Majority.
2	To what extend does the small-scale embedded generation (SSEG) buy back tariff encourage or deter the purchasing of a residential rooftop solar PV system?	2	Feed-in tariffs significantly motivate the adoption of residential rooftop solar PV systems by providing financial incentives that enhance the perceived economic benefits and reduce the payback period for homeowners.
3	Has load shedding led to an increase in residential rooftop solar PV systems adoption?	3	There is a chasm between the Early Adopters and the Early Majority.
		4	Frequent power outages due to loadshedding significantly accelerate the adoption of residential rooftop solar PV systems by enhancing the perceived relative advantage and compatibility of the technology, thereby facilitating the transition from early adopters to the early majority.

CHAPTER 3. RESEARCH METHODOLOGY

This chapter outlines the research design and explains the relevance of the research approach used to answer the research questions. It then discusses data collection methods, population and sampling methods, the research instrument, and data analysis methods. Finally, the study's limitations, validity, reliability, and ethical considerations are discussed.

3.1 Research approach

A quantitative research approach was used in this study to investigate the factors influencing the adoption of residential rooftop solar PV systems. Quantitative research provides a systematic and objective approach to studying the relationship between variables, which is essential for understanding the factors influencing residential solar PV adoption (Bondio et al., 2018; Schulte et al., 2022).

The literature review indicates that several factors, such as demographic characteristics, socioeconomic status, environmental attitudes, and perceived benefits and barriers, can influence the adoption of residential rooftop solar PV systems (Alipour et al., 2020; Menon & Sujatha, 2021; Rai & Beck, 2015; Schulte et al., 2022). Concerning Rodgers' theory of innovation diffusion, this allowed the researcher to contrast between the adopters in each adopter category, focusing on the above factors (Faiers & Neame, 2006; Rogers, 2003; Simpson & Clifton, 2017).

The quantitative research approach deployed descriptive statistics and logistic regression analysis to analyse the data and to determine the relationship between the dependent and independent variables and making predictions or estimations based on the relationship (Albert et al., 2012; Jin, 2012; Palmer & O'Connell, 2009; Wu & Little, 2011).

3.2 Research design

According to Yin (2017), the research design is the logic that links the data to be collected and the conclusions to be drawn to the initial questions of the study. This study used a descriptive quantitative design involving a questionnaire as the single data collection technique (Abutabenjeh & Jaradat, 2018; Žukauskas et al., 2018).

Descriptive methods are appropriate for describing the characteristics of a population or a phenomenon (Schulte et al., 2022), while quantitative research methods allow for the systematic collection and analysis of numerical data to identify patterns, trends, and relationships between variables (Rai & Beck, 2015).

A descriptive study provides for the current state of a phenomenon to be documented and its relationships explored (Austin & Sutton, 2014), which is particularly relevant for consumer adoption of emerging technologies like residential solar PV systems.

3.3 Data collection methods

Quantitative research data is collected through various methods such as questionnaires, surveys, and experiments (Ragab & Arisha, 2018). In this study, a self-administered questionnaire in APPENDIX A, was used to collect data from a representative sample of residential consumers. The questionnaire captured information on factors such as demographic characteristics, environmental attitudes, financial considerations, knowledge about solar energy, and intention to adopt residential solar PV systems.

The advantages of using a questionnaire include its ability to collect standardized data from a large sample size, the relative ease of administration, and the potential for quantifiable analysis of the data. Questionnaires also allow for anonymity, encouraging more honest responses on sensitive topics such as financial considerations or environmental concerns (Ranganathan & Caduff, 2023). The downside of a questionnaire includes the potential for low response rates and the inability to probe deeper into respondents' motivations and thought processes (Murdoch et al., 2014).

3.4 Population and sample

The population of this study was based on residents of the gated community of Midstream, which comprises of various Estates and Gates. According to the latest census data, the gated community has more than 6388 residential households[1].

3.4.1 *Population*

All residential households of Midstream Estates with or without Solar PV installation formed part of the study. The residential sector within the Midstream Estates was chosen as the target population due to the relatively high adoption rate of residential solar PV systems within the region, making it a relevant and appropriate context for this study. It is estimated that over 1000 residential households in Greater Midstream have adopted residential rooftop solar PV technology making the area suitable for the study[2]. Based on Rogers diffusion of innovation theory, the innovators and early adopters constitute 16% of the total population. The early adopters in this study referred to those who had adopted residential rooftop solar PV system, the early majority were participants who had not yet installed the residential rooftop solar PV system.

3.4.2 *Sample and sampling method*

The sampling technique for this study was random sampling, specifically self-selection sampling. Random sampling was appropriate as it provided each member of the population with an equal chance of being selected, minimising the

[1] https://www.midteam.co.za/template/ArticleDisplay.vm/articleid/7616
[2] https://www.news24.com/fin24/climate_future/solutions/gautengs-midstream-estate-plans-to-avoid-four-load-shedding-stages-with-r200m-project-20230218

risk of bias. In self-selection sampling, the participants do so because of their feelings or opinions about the research topic (McEwan, 2020). This was relevant as solar PV adoption may be a more salient topic for some residents than others. The study aimed to capture a diverse and representative sample of the target population, including those who have already adopted solar PV and those who have not, to understand the factors influencing residential solar PV adoption.

The disadvantage of this sampling technique is the potential self-selection bias, where participants who are more interested in and knowledgeable about solar PV may be more likely to respond (Murdoch et al., 2014). Thus, this technique has a low likelihood of the sample being representative of the population.

A sample size calculator was used to determine the appropriate number of survey respondents based on a 95% confidence level, a 5% margin of error, and an estimated response distribution of 50% (Kadam & Bhalerao, 2010). To calculate the sample size for a population of 6,388 with a 95% confidence level and a 5% margin of error, the following formula was used:

$$n = \frac{N \cdot Z^2 \cdot p \cdot (1-p)}{(N-1) \cdot E^2 + Z^2 \cdot p \cdot (1-p)}$$

Where:

- (n) is the sample size
- (N) is the population size (6,388)
- (Z) is the Z-score (1.96 for 95% confidence level)
- (p) is the estimated proportion of the population (0.5 is often used if unknown)
- (E) is the margin of error (0.05)

The required sample size was determined to be:

$$n = \frac{6388 \cdot 1.96^2 \cdot 0.5 \cdot (1 - 0.5)}{(6388 - 1) \cdot 0.05^2 + 1.96^2 \cdot 0.5 \cdot (1 - 0.5)}$$

$$n = \frac{6130.84}{15.9675 + 0.9604}$$

$$n \approx 362$$

Given the time constraints to conduct the research and slow response rate, the final number of participants was 153 of which 140 were valid. This represented a margin of error of 8.19% compared to the 5% above for a 95% confidence level.

Table 2. Household respondents by adopter type

Households	Number to be sampled
Households with rooftop solar PV system installation (early adopters)	99
Households without rooftop solar PV system installation (early majority)	41
TOTAL number of respondents	140

Given that the survey was self-selecting, there was a skew towards early adopters indicating self-selection bias, where participants who are more interested in and knowledgeable about solar PV may be more likely to respond (Murdoch et al., 2014). All the results were analysed and insights drawn from them regardless of the skew relative to early majority.

3.5 The research instrument

This study will utilise questionnaire as a single data collection technique for data collection, included in APPENDIX A – Research Instrument. Questionnaires are relatively inexpensive to administer and allow for reach to a large number of respondents quickly and efficiently. The structured format ensures that all respondents answer the same questions in the same way, allowing for easier comparison and analysis (Ranganathan & Caduff, 2023). But due to their closed-ended questions, they can limit the depth and richness of the data collected (Ranganathan & Caduff, 2023). Respondents may not answer truthfully or accurately due to social desirability bias or a desire to present themselves in a favourable light and collecting a sufficient number of responses can be challenging, especially with self-administered questionnaires. (Bush & White, 1985).

The questionnaire included questions that cover various aspects related to residential rooftop solar PV adoption, such as demographic information (age, gender, income), attitudes towards renewable energy, knowledge about solar PV systems, perceived benefits and barriers of adoption, and motivations to adopt solar PV in the future (Vasseur & Kemp, 2015a).

Additionally, the questionnaire included questions to measure the level of awareness about government incentives or subsidies for solar PV adoption, previous experiences with renewable energy technologies, and concerns related to the installation and maintenance of solar PV systems (Robinson & Rai, 2015).

According to Kurdgelashvili et al. (2019) the inclusion of these questions allows the researcher to obtain a comprehensive understanding of the factors influencing residential rooftop solar PV adoption and identify any patterns or correlations between variables. The questionnaire also included questions that capture respondents' perceptions of the relative advantages of solar energy compared to other alternatives, as well as their beliefs about the affordability and environmental benefits of solar PV systems (Bondio et al., 2018).

Questionnaires should be designed in a way that allows for accurate and reliable data collection (Robinson & Rai, 2015). This can be done by ensuring clear and concise wording of questions, providing response options that cover a range of possible answers, and incorporating appropriate skip patterns or branching logic to guide respondents through the survey (Robinson & Rai, 2015).

The questionnaire design recognised two sets of respondents, those who have already adopted and those who have not adopted the residential rooftop solar PV system. The last section on the technical data, installation costs from the implementation of the system was only applicable to those who have already adopted.

3.6 Procedure for data collection

Participants were contacted through the community social media platforms such as the closed Facebook groups and neighbourhood WhatsApp groups to distribute. The link to the online questionnaire and a brief description was shared on these platforms to facilitate data collection from a broader sample of the target population. The online format allowed for greater reach and convenience for the participants. At the same time, the community-based approach helped to engage the specific target audience of residential homeowners in Midstream Estates. Upon accessing the online questionnaire, the respondents were presented with an introduction and informed consent outlining that their participation was voluntary and that they could withdraw at any time. It was also be highlighted that the data will be kept strictly confidential and anonymous. The respondents were also informed that they could access the summary of the study results by contacting the researcher or the supervisor. A regular reminder was sent to the groups to encourage participation as these groups tend to be busy with lots of information being shared, and the study could be lost. Data was collected over eight weeks, as the initial response rate was low.

3.7 Data analysis and interpretation

Data obtained from this study was analysed using the Logistic Regression Analysis statistical method and descriptive statistics. Regression analysis is a statistical analysis method that allows researchers to determine the quantitative relationship between variables (Chatterjee & Hadi, 2015). Quantitative research methods using regression analysis are commonly used to analyse the relationship between variables and make predictions or estimations based on that relationship (Albert et al., 2012; Jin, 2012; Palmer & O'Connell, 2009; Wu & Little, 2011). Furthermore, regression analysis can be used to control for other variables that may influence the relationship between the independent and dependent variables.

Regression Analysis was used to examine the relationship between a dependent variable and one or more independent variables. In the context of residential rooftop solar PV adoption, regression analysis was used to analyse the impact of various factors on the likelihood for adoption. The factors included demographic variables such as age, income, and education level, as well as attitudinal variables such as awareness of government incentives and beliefs about affordability and environmental benefits of solar PV systems. Through conducting regression analysis, the strength and direction of the relationships between these variables and residential rooftop solar PV adoption can be determined (Vasseur & Kemp, 2015b).

3.8 Limitations of the study

The study's limitations included using a non-probability sampling approach, which may limit the generalisability of the findings to the broader population. The use of a closed-question questionnaire limits the solicitation of a respondent's views; therefore, specific insights were probably missed, and some respondents might have felt limited or would have liked to express themselves more.

Additionally, the nature of the self-administered questionnaires may lead to biases, such as social desirability or recall bias. Social desirability bias is where respondents may tend to answer questions in a way that is perceived as more socially acceptable or favourable rather than providing their actual opinions or behaviours (Grimm, 2010). Recall bias is where respondents may not accurately recall or report past events, behaviours, or experiences(Bradburn et al., 1978). This can lead to inaccurate data and skewed results.

The study was undertaken in an upmarket estate in South Africa, reflecting a relatively affluent setting; consequently, the findings may not be generalisable to the wider South African population.

3.9 Validity and reliability

In quantitative research, the validity and reliability of the data collected are crucial for the research findings to be considered robust and applicable to a population or a similar context. To ensure validity, the research instrument should be carefully designed and pre-tested to measure the intended constructs accurately (Ranganathan & Caduff, 2023).

Potential biases in the research should be addressed by employing strategies such as randomising question order, including attention checks, and careful wording of questions to minimise social desirability bias (Choi & Pak, 2005). Additionally, the sampling approach should aim to reach a representative cross-section of the target population to enhance the generalisability of the findings (Sjöström & Holst, 2002).

3.9.1 *External validity*

Random sampling allows for greater generalisability by ensuring that each member of the population has an equal chance of being selected. This reduces the risk of selection bias while enhancing the external validity of the study. The study was limited to a set context, an upmarket gated residential estate, this reduced its generalisability to the wider population and the ability to replicate the study elsewhere may be limited. However, the insights on the factors influencing the adoption decision will be useful in wider contexts and may influence policy and future research.

3.9.2 *Internal validity*

Internal validity refers to how well a study can accurately establish a cause-and-effect relationship between the independent and dependent variables (Zohreh & Martin, 2017). It indicates the level of certainty with which one can assert that the findings of a study are definitive and unaffected by external influences or modifications.

It also refers to the extent to which a questionnaire accurately measures what it intends to assess, while acknowledging the inherent constraints associated with any study (Ranganathan & Caduff, 2023). The questionnaire in this study was based on similar questionnaires found in the literature review of studies conducted worldwide.

3.9.3 *Reliability*

Reliability refers to the consistency of results when the study is conducted multiple times, even by different researchers (Ranganathan & Caduff, 2023). Any variations in the outcomes should be attributed to genuine differences between participants rather than issues with how the questions are interpreted or answered (Ranganathan & Caduff, 2023).

Reliability may involve internal consistency evaluations, such as Cronbach's alpha and test-retest reliability (Sjöström & Holst, 2002). An important aspect of maintaining reliability is ensuring that the collected data remains consistent and stable, leading to reproducible results. Cronbach's alpha is frequently used to gauge the internal consistency of a survey instrument. This metric was used to assess the extent to which the items within a scale or construct are linked, with a high Cronbach's alpha value (typically above 0.7) indicating a high degree of reliability (Sjöström & Holst, 2002).

3.9.4 *Objectivity*

Research findings should be objective, without undue influence from the researcher's personal biases or preconceptions (Mehra, 2002). Throughout the research process, from designing the study to analysing the data and interpreting the results, researchers should aim to remain neutral and impartial (Mehra, 2002).

3.10 Ethical considerations

Researchers are responsible for ensuring that their research will not infringe on the rights and safety of the respondents (Akaranga & Makau, 2016). The study followed the ethical guidelines provided by the University of the Witwatersrand. Zyphur and Pierides (2017) indicate that stating the limitations of the research and placing non-disclosure statements at the beginning of the questionnaire can build confidence and trust among the respondents.

While the study did not require the respondents' identification data, demographic data such as gender, age, level of education, household income, and purchasing behaviour were required. This allowed for understanding of the different adopter groups as indicated in literature.

Informed consent was obtained from the respondents before they completed the questionnaire. The identity of the respondents is unknown to the researcher and remains anonymous. In cases where respondents would like a copy of the research results, their request can be sent to the supervisor or the researcher. Still, there will be no way of identifying individual questionnaire responses, only the aggregate results.

To ensure the security of the research data, a password-protected computer and securely logged cloud storage (Google Drive) were used to store the data obtained from this research. Additionally, upon completion of the study, consent will be obtained to store the data for future analysis for a period not exceeding five years on a secure, password-protected storage.

3.11 Consistency table

The consistency table below shows the thread from research questions, hypothesis, data collection detail and data analysis method.

Table 3. Consistency table: research questions, hypothesis, data collection and data analysis

RQ #	Research Question	Hyp #	Hypothesis	Data collection detail	Data analysis method
1	What are the personal circumstances, beliefs and attitudes that motivate towards the adoption of residential rooftop solar PV systems?	1	There is no demographic, psychographic, and motivational difference between the Early Adopters and the Early Majority.	Questionnaire Part 1: Questions 1-10 Part 2: Likert statements 1 - 16 Part 3: Questions 14 - 17	Descriptive statistics and Regression Analysis
2	To what extend does the small scale embedded generation (SSEG) buy back tariff encourage or deter the purchasing of a residential rooftop solar PV system?	2	Feed-in tariffs significantly motivate the adoption of residential rooftop solar PV systems by providing financial incentives that enhance the perceived economic benefits and reduce the payback period for homeowners.	Questionnaire: Part 2: Q13 Likert statements 1-7 Part 3: Q14, Q15, Q17	Descriptive statistics and Regression Analysis

RQ #	Research Question	Hyp #	Hypothesis	Data collection detail	Data analysis method
3	Has load shedding led to an increase in residential rooftop solar PV systems adoption?	3	There is a chasm between the Early Adopters and the Early Majority.	Questionnaire: Part 1: Q9 Part 3: Q14, Q15, Q17	Descriptive statistics and Regression Analysis
		4	Frequent power outages due to loadshedding significantly accelerate the adoption of residential rooftop solar PV systems by enhancing the perceived relative advantage and compatibility of the technology, thereby facilitating the transition from early adopters to the early majority.	Questionnaire: Part 1: Q9 Part 2: Q13 Likert statements 1-7 Part 3: Q14 - Q21	Descriptive statistics and Regression Analysis

CHAPTER 4. PRESENTATION OF RESULTS

4.1 Introduction

This chapter provides the results from the statistical analysis of the data obtained from the completed questionnaire. Descriptive statistics and logistic regression data will be presented starting with outlining the demographic statistics, followed by presenting results relating to the study hypothesis and finally will summarise the results.

4.2 Final Survey Data

The online questionnaire had a total of 153 responses and only 145 responses were taken as final data. The usable and most complete responses from this final set (N = 145), was 140 responses. The statistical tool used for analysis is IBM® SPSS Statistics version 30.

4.3 Demographic profile of respondents

The participants with residential rooftop solar PV systems installation were higher (70.7%) than those without (29.3%) as shown in **Figure 13**.

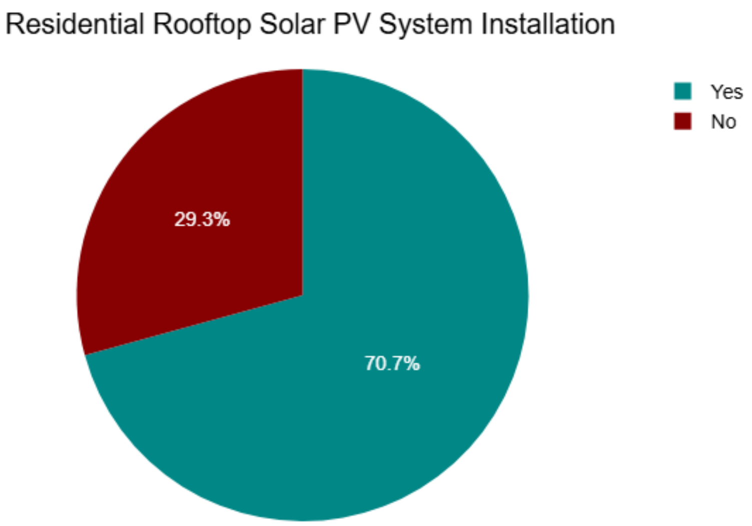

Figure 13: Residential rooftop solar PV system installation (N = 140)

The participation of females in the study was higher (60.7%) compared to male participants (39.3%) as shown in **Figure 14** and **Table 6**. While the demographics of the population in this study are unknown, the 2024 Mid-year population estimates for South Africa indicate a higher female population (51.0%) compared to male population (49.0%) (Statistics South Africa, 2024).

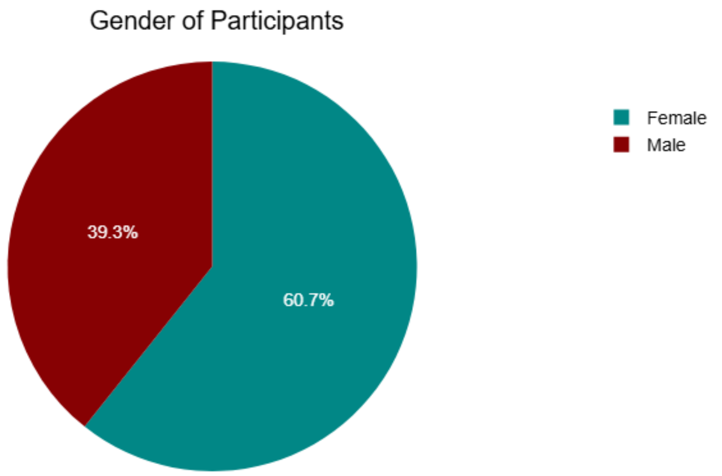

Figure 14: Gender distribution of Participants (N = 140)

The female participants that had residential rooftop solar PV system installed (72.9%) were higher than male participants (67.3%) that had residential rooftop solar PV system installed as shown in **Figure 15**.

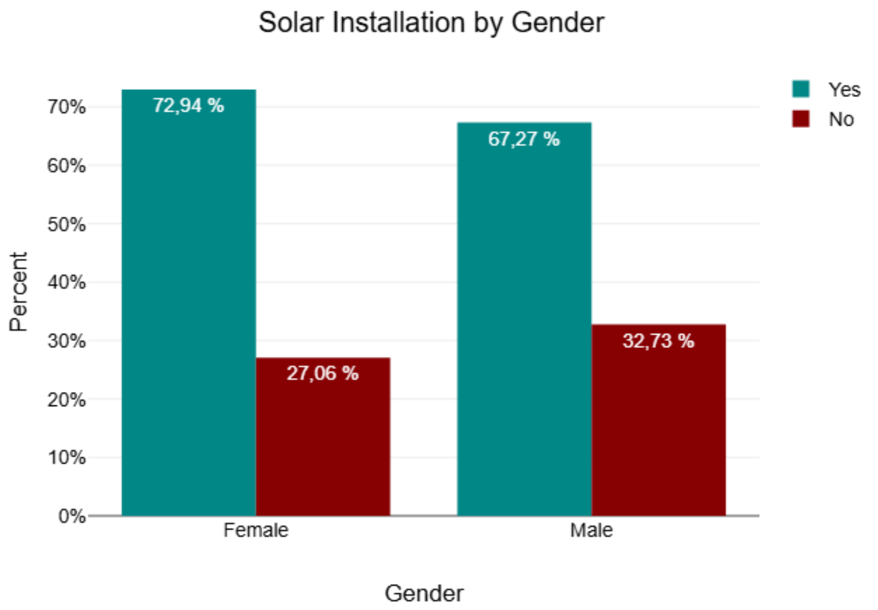

Figure 15: Solar Installation by gender (N = 140)

The mean age (± standard deviation) of the participants was 46 (±10) years and the female mean age (± standard deviation) is 45 (± 9) years, while the male mean age (± standard deviation) is 47 (± 11) years. While the mean age by solar installation is 46 (± 11) years for those who have solar installation and those without is 46 (± 8) years, as shown in **Table 4**.

Table 4. Mean age by solar installation

		Frequency	%	Mean	Std. Deviation	Minimum	Maximum
Age	Yes	99	70,71%	45,95	10,58	18	74
	No	41	29,29%	45,78	7,76	24	71

Most participants (82.3%) who had installed solar PV system and those who had not installed solar PV system (87.8%), had a university degree as shown in **Figure 16**.

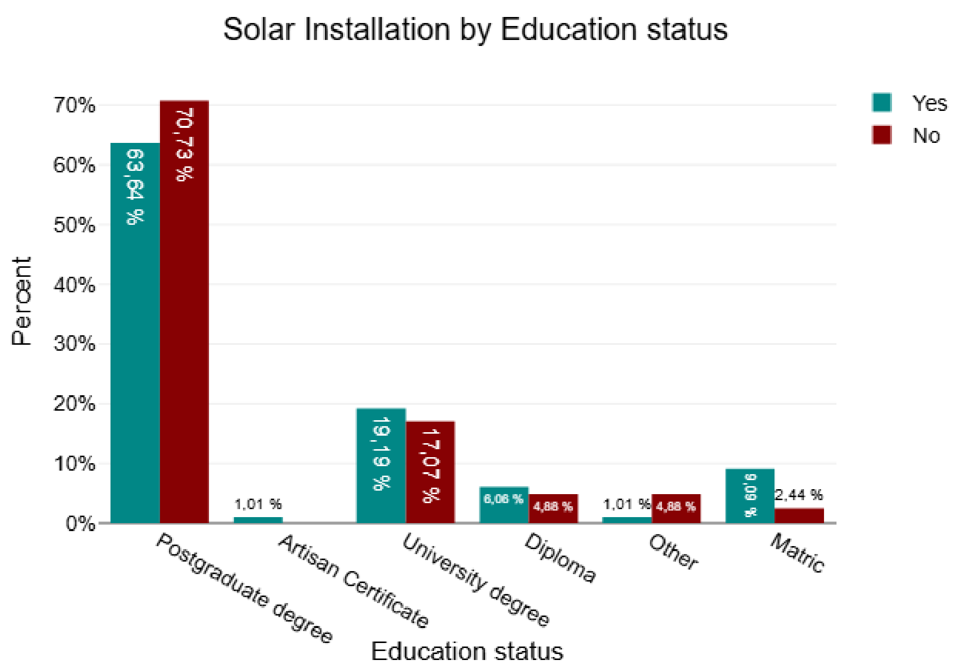

Figure 16: Solar Installation by education status (N = 140)

The household size for participants who have installed solar PV systems were similar for 2 to 4 people in a household with the highest (36.4%) in households with 5 or more people. Meanwhile for households without solar PV system installation, the 3 or more people per household were increasingly higher with the 5 or more people the highest (46.4%) as shown in **Figure 17**.

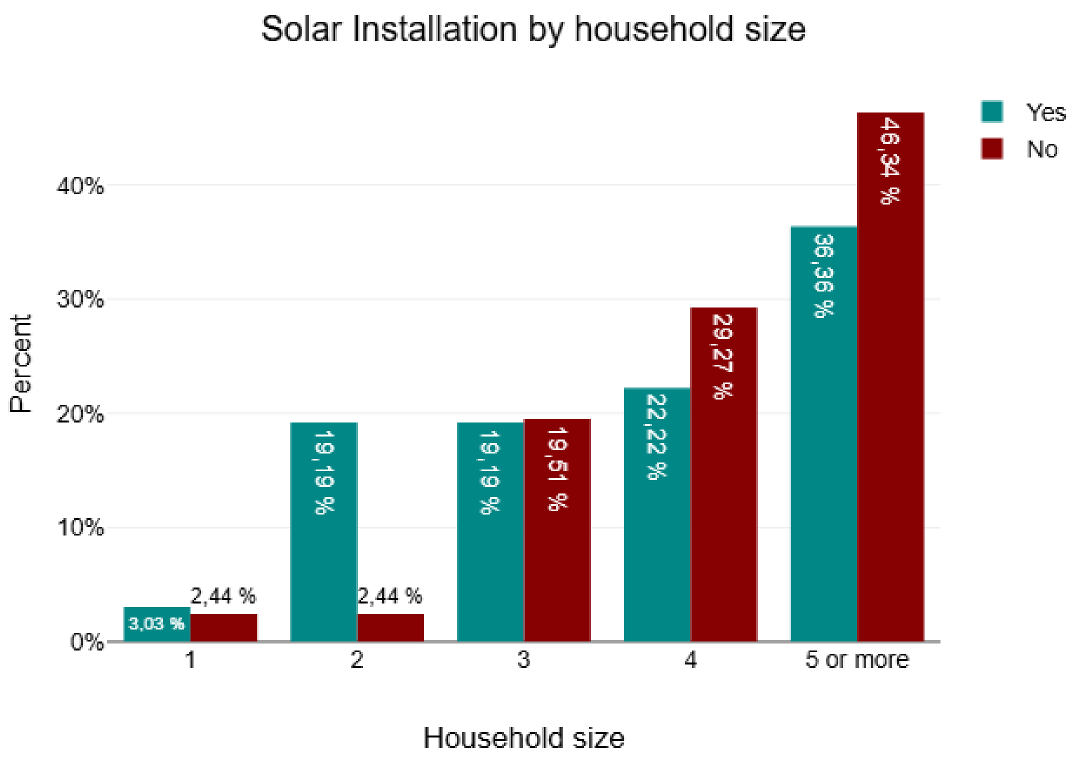

Figure 17: Solar Installation by household size (N = 140)

Figure 18 shows that the employment status for participants with and without solar PV system installed were similar with 57.6% and 68.3% respectively in fulltime employment and 22.2% and 24.4% respectively self-employed.

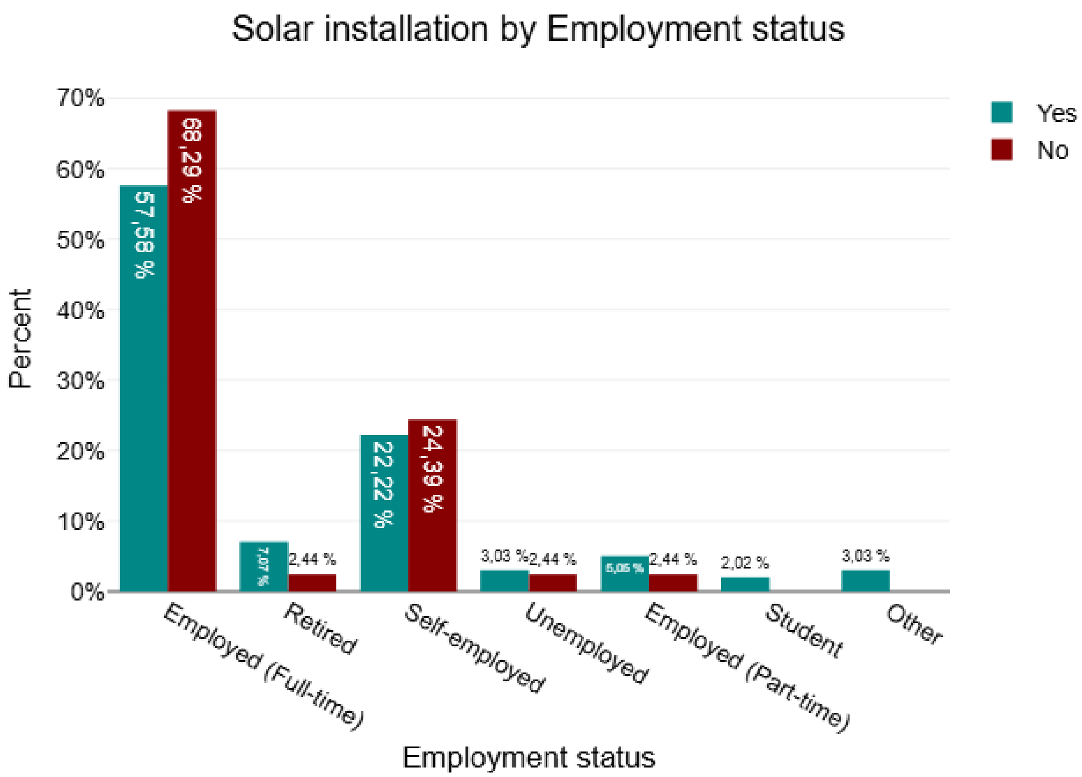

Figure 18: Solar Installation by employment status (N = 140)

The monthly household income of R150,000 or more was the highest for both those with solar PV systems installed (42.4%) and not installed (31.7%), followed by the R100,000 – R149,000 category for installed (22.2%) and not installed (29.3%). The R60,000 – R79,000 was the third highest for installed (13.1%) while the R80,000 – R99.999 is the third highest for not installed (17.1%). Most of the participants monthly household income was R40,000 or more, with those with solar PV systems installed at 96.9% and those without at 97.7%, as shown in **Figure 19**.

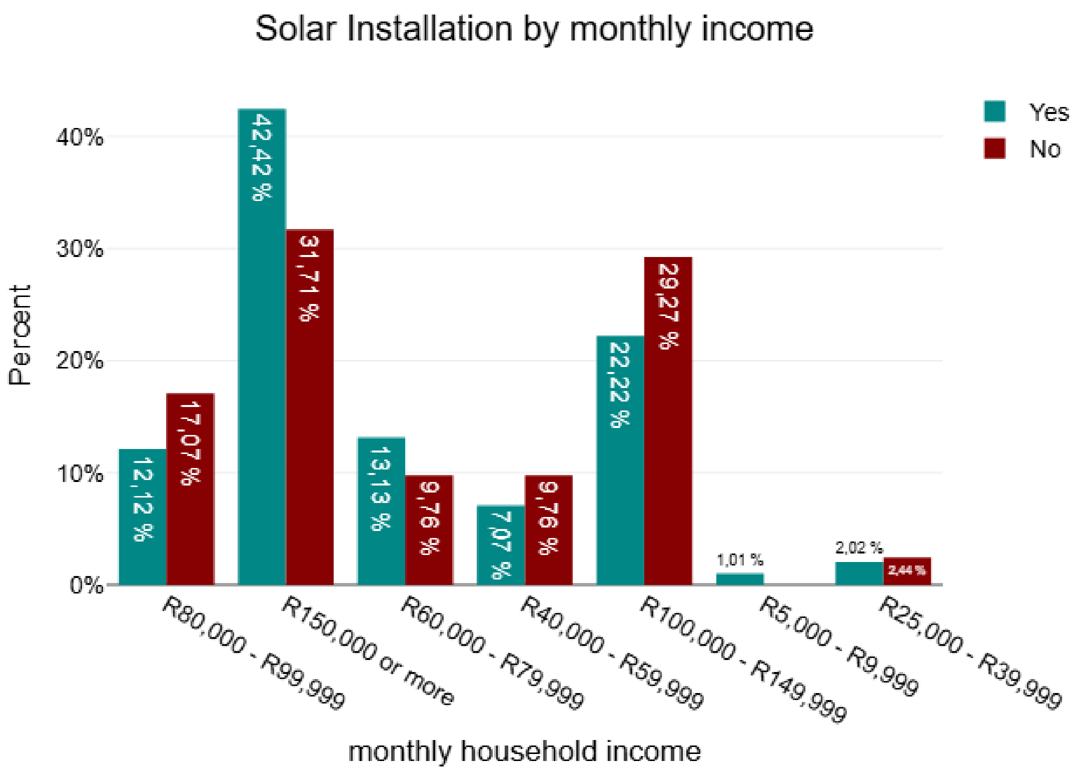

Figure 19: Solar Installation by monthly household income (N = 140)

In **Table 5** below, the green initiatives of the participants highlighting Energy saving light bulbs and Gas stove as the top 2 initiatives. Gas timer versus Roof insulation for the third but broadly similar beliefs on green initiatives.

Table 5. Participants Green initiatives

Green Initiatives	Solar PV System Installation	
	Yes	No
Roof insulation	26%	39%
Energy saving light bulbs (e.g. LED light)	**73%**	**71%**
Automatic light switches	13%	15%
Geyser blanket	25%	27%
Solar Geyser	31%	29%
Geyser timer	**51%**	**32%**
Water saving taps and shower heads	12%	7%
Gas heating	37%	27%
Gas stove	**61%**	**71%**
Recycling	44%	34%

The full socio-demographic statistics of the sample are provided in **Table 6**.

Table 6. Demographic statistics of the sample

	Frequency (N)	Percent (%)
Gender		
Male	55	39%
Female	85	61%
Total	140	100%
Level of Education		
Martic	10	7%
Artisan Certificate	1	1%
Diploma	8	6%
University degree	26	19%
Postgraduate degree	92	66%
Other	3	2%
Total	140	100%
Household size		
1	4	3%
2	20	14%
3	27	19%
4	34	24%
5 or more	55	39%
Total	140	100%
Employment Status		
Student	2	1%
Employed (Full-time)	85	61%
Employed (Part-time)	6	4%
Self-employed	32	23%
Unemployed	4	3%
Retired	8	6%
Other (Please specify)	3	2%
Total	140	100%
Household Income		
R5,000 - R9,999	1	1%
R25,000 - R39,999	3	2%
R40,000 - R59,999	11	8%
R60,000 - R79,999	17	12%
R80,000 - R99,999	19	14%
R100,000 - R149,999	34	24%
R150,000 or more	55	39%
Total	140	100%

4.4 Logistic Regression Analysis

The participant's attitude towards the adoption of residential rooftop solar PV systems indicated a strong agreement (mean = 1.57) that *solar systems as a technology can develop in the future*, followed by the attitude that *solar systems add value to their property* (mean = 1.65) and *solar power is compatible with modern living* (mean = 1.65). On the disagreement side, *solar systems are an affordable technology* (mean = 3.83), and *solar systems require the same amount of maintenance as grid power sources* (mean = 3.64) as shown in **Table 7**.

Table 7. Mean score of participants attitudes

Participants Attitudes towards residential rooftop solar PV systems[a]

	N	Minimum	Maximum	Mean	Std. Deviation
It takes a long period to recoup the financial investment	137	1	5	2,40	1,108
There is a low level of feed-in tariffs (sell back price	137	1	4	1,88	,841
Solar systems help to reduce pollution in the environment	137	1	5	1,88	,844
Solar systems generate savings	137	1	5	1,99	,903
Solar systems require the same amount of maintenance as grid power source ("Eskom")	137	1	5	3,64	,881
Solar systems are intrusive and affect the aesthetics of your home	137	1	5	3,83	,997
Solar systems are value for money	137	1	5	2,02	,927
Solar systems are an affordable technology	137	1	5	3,23	1,043
Solar provides a reliable source of power	137	1	5	1,96	,736
Solar systems could develop in the future	137	1	3	1,57	,592
Solar systems add value to a property	137	1	3	1,65	,682
Solar systems reduce carbon emissions	137	1	4	1,81	,800
Solar systems provide a visual statement of beliefs	137	1	5	2,65	,936
Solar systems are easy to install	137	1	5	2,76	1,033
Solar systems are a safe form of power generation	137	1	4	1,88	,687
Solar power is compatible with modern living	137	1	5	1,65	,648

a. Mean results: 1 = Strongly Agree, 2 = Agree, 3 = Neither agree nor disagree, 4 = Disagree, 5 = Strongly disagree

The logistic regression on the attitudes had two statistically significant attitudes, "there is a low level of feed-in tariffs" with a coefficient (B) of 0.839 (p = 0.005) and "Solar systems are an affordable technology" with a coefficient (B) of 0.529 (p = 0.037) as shown in **Table 8**.

Table 8. Participants attitudes logistics regression

	B	S.E.	Wald	df	Sig.	Exp(B)
It takes a long period to recoup the financial investment	-,268	,245	1,194	1	,274	,765
There is a low level of feed-in tariffs (sell back price	,839	,297	7,985	1	,005	2,314
Solar systems help to reduce pollution in the environmen	-,747	,398	3,524	1	,060	,474
Solar systems generate savings	,207	,305	,464	1	,496	1,230
Solar systems require the same amount of maintenance as grid power source	-,342	,257	1,779	1	,182	,710
Solar systems are intrusive and affect the aesthetics of	,311	,263	1,395	1	,238	1,364
Solar systems are value for money	-,462	,314	2,170	1	,141	,630
Solar systems are an affordable technology	,529	,254	4,339	1	,037	1,697
Solar provides a reliable source of power	,621	,348	3,193	1	,074	1,862
Solar systems could develop in the future	-,044	,462	,009	1	,923	,956
Solar systems add value to a property	-,023	,384	,004	1	,952	,977
Solar systems reduce carbon emissions	,258	,350	,541	1	,462	1,294
Solar systems provide a visual statement of beliefs	,448	,282	2,522	1	,112	1,565
Solar systems are easy to install	-,482	,247	3,812	1	,051	,618
Solar systems are a safe form of power generation	,688	,450	2,342	1	,126	1,991
Solar power is compatible with modern living	-,096	,434	,049	1	,825	,909
Constant	-4,405	2,193	4,033	1	,045	,012

Among the barriers, 66% of participants identified "High initial costs of solar PV systems" as a major barrier. In contrast, 31% of participants indicated that "low feed-in tariffs" were not a barrier, as shown in **Table 9**.

Table 9. Participants perceptions of barriers to adoption

	Not a Barrier	Minor Barrier	Moderate Barrier	Major Barrier
High initial cost	3%	7%	24%	66%
Lack of information	20%	31%	32%	17%
Technical concerns	20%	43%	24%	12%
Regulatory or permitting issues	20%	32%	31%	17%
Low feed-in tariffs or sell back price	31%	24%	28%	17%

Logistic regression on the barriers indicated that only lack of information had a statistically significant ($p = 0.015$) outcome with a coefficient (B) of -0.656, indicating a negative impact of the lack of information on residential rooftop solar PV systems to adoption as shown in **Table 10**.

Table 10. Linear logistic regression of participants perceptions of barriers to adoption

	B	S.E.	Wald	df	Sig.	Exp(B)
High initial cost	,538	,322	2,791	1	,095	1,712
Lack of information	-,656	,269	5,940	1	,015	,519
Technical concerns	,356	,302	1,389	1	,238	1,427
Regulatory or permitting issues	,006	,241	,001	1	,981	1,006
Low feed-in tariffs or sell back price	-,194	,212	,830	1	,362	,824
Constant	-1,631	1,331	1,501	1	,221	,196

4.5 Results pertaining to Hypothesis 1

Hypothesis 1: *There is no demographic difference between the Early Adopters and the Early Majority.*

Table 11. Participants demographics logistics regression

	B	S.E.	Wald	df	Sig.	Exp(B)
What is your gender?	-,253	,397	,406	1	,524	,776
Your Age	,020	,024	,697	1	,404	1,020
What is the highest level of education you have completed?	,211	,229	,853	1	,356	1,235
How many people live in your household?	,331	,196	2,860	1	,091	1,392
What is your occupation?	-,248	,175	2,009	1	,156	,780
Please indicate the category which best describes your monthly combined household income (net / take-home)?	-,153	,137	1,256	1	,262	,858
Constant	-2,139	2,198	,947	1	,331	,118

The logistic regression of the participants gender, age, education level, household size, occupation and monthly income indicates both positive and negative relationships to adoption of rooftop solar PV based on the coefficient (B) in **Table 11**, but none of the factors are statistically significant as their p-values (Sig) is greater than 0.05.

In terms of beliefs, **Table 5** indicates little differences on the green initiatives participants had in place, with Energy saving light bulbs and Gas stove the most in place. The logistic regression on the attitudes in **Table 8** had two statistically significant attitudes, "there is a low level of feed-in tariffs" with a coefficient (B) of 0.839 ($p = 0.005$) and "Solar systems are an affordable technology" with a coefficient (B) of 0.529 ($p = 0.037$).

The hypothesis that there is no demographic difference between the Early Adopters and the Early Majority is supported on the personal circumstances, beliefs and mostly (14/16) on the attitudes.

4.6 Results pertaining to Hypothesis 2

Hypothesis 2: *Feed-in tariffs significantly motivate the adoption of residential rooftop solar PV systems by providing financial incentives that enhance the perceived economic benefits and reduce the payback period for homeowners.*

Table 12. Impact of feed-in tariffs on adoption decision-making

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	The tariffs were a major factor in my decision	14	9,7	10,9	10,9
	The tariffs played a role, but other factors were also important	25	17,2	19,4	30,2
	The tariffs had a minor impact on my decision	27	18,6	20,9	51,2
	The tariffs did not affect my decision at all	63	43,4	48,8	100,0
	Total	129	89,0	100,0	
Missing	System	16	11,0		
Total		145	100,0		

Most participants (43.4%) indicated that the tariffs did not affect their decision-making at all and 18.6% indicated that the tariffs had a minor impact on their decision-making, with only 9.7% indicating that the tariffs were a major factor in their decision-making as shown in **Table 12**.

Table 13. Participants attitudes logistics regression

Variables in the Equation

	B	S.E.	Wald	df	Sig.	Exp(B)
There is a low level of feed-in tariffs (sell back price	,535	,255	4,380	1	,036	1,707
How did the feed-in tariffs offered by Midstream Electrical Services (MES) for selling back electricity from your solar PV system influence your decision to install rooftop solar PV system?	-,861	,204	17,896	1	<.001	,423
Constant	,588	,790	,555	1	,456	1,801

The regression analysis in **Table 13** indicated that the low level of feed-in tariffs was statistically significant with a coefficient (B) of 0.535, and a p-value (Sig.) of 0.036, indicating that a low level of feed-in tariffs increased the likelihood of adopting rooftop solar PV. The odds ratio of 1.707 suggested that respondents perceiving low feed-in tariffs were 70.7% more likely to adopt rooftop solar PV.

At the same time, the influence of feed-in tariffs on the decision to install rooftop solar PV system were statistically significant with a coefficient (B) of -0.861, and a p-value (Sig.) less than 0.001, indicating that favourable feed-in tariffs offered by MES decrease the likelihood of adopting rooftop solar PV. The odds ratio of 0.423 suggested that respondents influenced by favourable MES feed-in tariffs were 57.7% less likely to adopt rooftop solar PV. Thus, the hypothesis was not supported as both factors point to other factors influencing the adoption other than the feed-in tariffs.

4.7 Results pertaining to Hypothesis 3

Hypothesis 3: *A chasm exists between the Early Adopters and the Early Majority.*

The age of residential solar PV installation amongst respondents who had installed solar PV systems indicate that the majority (52%) of the installations where in the 1 – 3 years between the years 2021 and 2023, while 32% of the installations took place in the 3-5 years, which is between 2019 and 2021. South Africa experienced the highest levels of loadshedding in the period 2021 to the first half of 2024 as shown in ***Figure 6***. The cumulative age of the solar PV installation follows an s-curve and can be fitted with a polynomial 3rd order curve with an R^2 of 0.9931 which is representative as shown in **Figure 20**. Worth noting that in 2024 only 6% of the participants installed solar PV systems coinciding with the reduction in loadshedding.

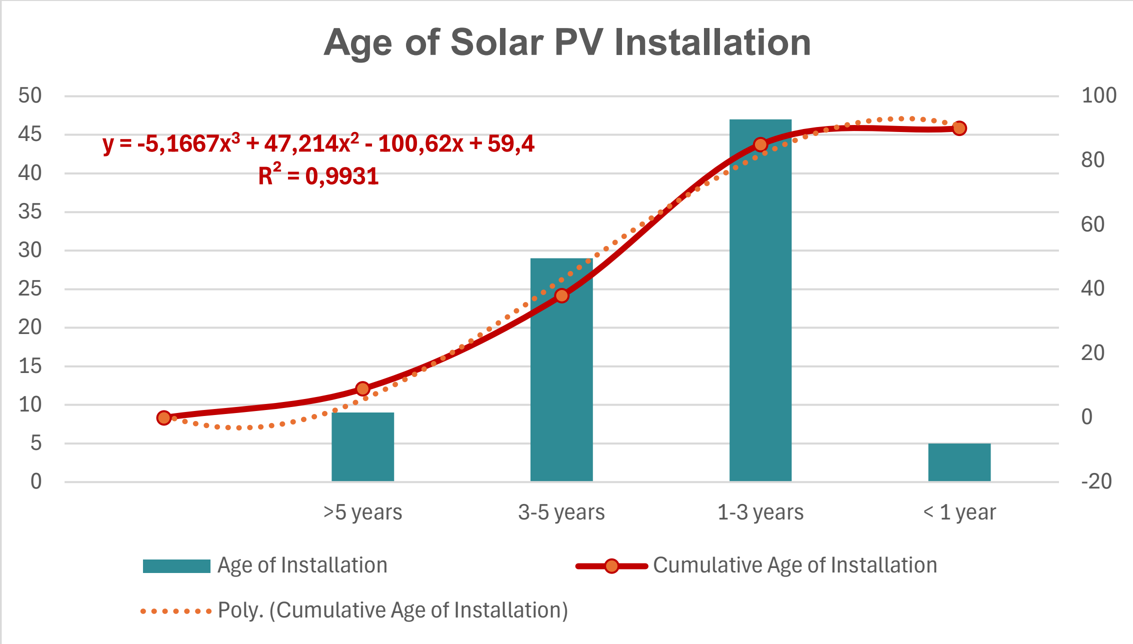

Figure 20: Age of Solar PV Installation

The motivators for adoption across both adopter groups, shown in **Table 14**, indicate that Power Reliability is ranked highest, followed by Economic Benefits, followed by Environmental Concerns then Technological interest and lastly Social Influence.

Table 14. Statistics on motivators for adoption

	n	Mean	Median	Standard deviation
Environmental Concerns	127	3	3	1.1
Economic Benefits	127	2.01	2	0.72
Technological Interest	127	3.72	4	0.78
Social Influence	127	4.61	5	0.69
Power Reliability	127	1.66	1	1.16

The Friedman Test results:

Chi^2	df	p
298.76	4	<.001

The results of the Friedman test show that the Chi-square statistic is 298.76 with 4 degrees of freedom and a p-value of < 0.001. This indicates that there are statistically significant differences in the rankings of the motivators (Environmental Concerns, Economic Benefits, Technological Interest, Social Influence, and Power Reliability).

The Pairwise comparison (Dunn-Bonferroni test) reveals that most pairwise comparisons show significant differences, indicating that respondents rank these motivators differently. The only non-significant comparison is between Economic Benefits and Power Reliability, suggesting that respondents do not significantly differentiate between these two motivators in terms of their importance.

Table 15. Pairwise comparison of motivators

	Test statistics	Standard error	Std. test statistics	p	Adj. p
Environmental Concerns - Economic Benefits	0.99	0.2	5	<.001	<.001
Environmental Concerns - Technological Interest	-0.72	0.2	-3.65	<.001	.001
Environmental Concerns - Social Influence	-1.61	0.2	-8.1	<.001	<.001
Environmental Concerns - Power Reliability	1.34	0.2	6.75	<.001	<.001
Economic Benefits - Technological Interest	-1.72	0.2	-8.65	<.001	<.001
Economic Benefits - Social Influence	-2.6	0.2	-13.1	<.001	<.001
Economic Benefits - Power Reliability	0.35	0.2	1.75	.081	.404
Technological Interest - Social Influence	-0.88	0.2	-4.44	<.001	<.001
Technological Interest - Power Reliability	2.06	0.2	10.4	<.001	<.001
Social Influence - Power Reliability	2.94	0.2	14.84	<.001	<.001

Power Reliability and Economic Benefits are both highly important motivators as ranked higher than others, and respondents do not significantly differentiate between them ($p > 0.05$).

The power reliability and economic benefits motivators together with the installation profile that follows the s-curve adoption profile, support the hypothesis that there exists a chasm between the adopters. The increase in adoption is driven by either of the motivators or a combination of both among the participants and these are statistically significant.

Table 16. Logistic regression on Power reliability and Economic benefits

	B	S.E.	Wald	df	Sig.	Exp(B)
Power Reliability	,462	,165	7,808	1	,005	1,587
Economic Benefits	-,055	,287	,037	1	,848	,946
Constant	-1,583	,723	4,799	1	,028	,205

The logistic regression analysis of the variables reveals that "Power Reliability" is statistically significant with a coefficient (B) of 0.462, and a p-value (Sig.) of 0.005, indicating that improved power reliability increases the likelihood of adopting rooftop solar PV. However, "Economic Benefits" is not statistically significant, with a coefficient (B) of -0.055 and a p-value (Sig.) of 0.848.

4.8 Results pertaining to Hypothesis 4

Hypothesis 4: *Frequent power outages due to loadshedding significantly accelerate the adoption of residential rooftop solar PV systems by enhancing the perceived relative advantage and compatibility of the technology, thereby facilitating the transition from early adopters to the early majority as described by Rogers' Diffusion of Innovations theory and Moore's Crossing the Chasm theory.*

The influence of loadshedding on the decision to install residential rooftop solar PV systems varies between those who have installed and those who have not installed. 50.5% of those who have installed indicate that they would not have installed if there was no loadshedding, while only 39.5% of those who have not installed indicated that they would not consider installing if there is no loadshedding as shown in **Figure 21**.

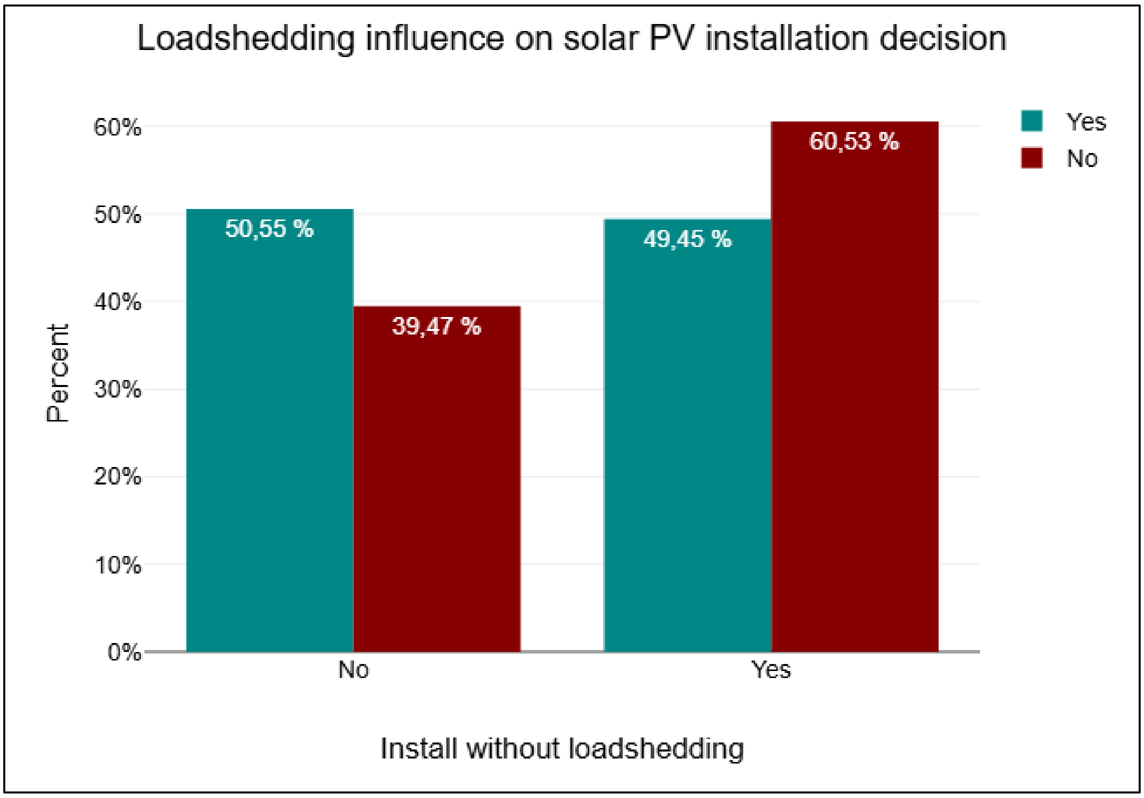

Figure 21: Comparison of loadshedding influence on residential rooftop solar PV installation decision

The logistic regression analysis reveals that "Power Reliability" is a statistically significant predictor with a coefficient (B) of 0.469 and a p-value (Sig.) of 0.004. The odds ratio (Exp(B)) is 1.6, indicating that improved power reliability increases the likelihood of adopting rooftop solar PV by about 60% thus supporting the hypothesis as shown in **Table 17**.

Table 17. Logistic regression on Power reliability as a motivator

	B	S.E.	Wald	df	Sig.	Exp(B)
Power Reliability	,469	,161	8,509	1	,004	1,599
Constant	-1,705	,353	23,293	1	<.001	,182

4.9 Summary of the results

The chapter presented both the descriptive analysis, logistic regression analysis and the interpretation of the results. The results indicate a higher participation rate (70.7%) from participants who have installed residential rooftop solar PV systems and higher participation (60.7%) by females. The mean age of the participants was 46 years, and majority of participants (84.3%) had a university degree and were employed full-time (60.71%). The majority (39.2%) of the participants lived in a household with 5 or more people and that majority (89.3%) had a monthly household income of R60,000 or more.

The participant's attitude towards the adoption of residential rooftop solar PV systems indicated a strong agreement (mean = 1.57) that solar systems as a technology can develop in the future, followed by the attitude that solar systems add value to their property (mean = 1.65). The logistic regression on the attitudes had two statistically significant attitudes, "there is a low level of feed-in tariffs" with a coefficient (B) of 0.839 ($p = 0.005$) and "Solar systems are an affordable technology" with a coefficient (B) of 0.529 ($p = 0.037$).

In terms of barriers, "High initial costs of solar PV systems" was identified as a major barrier by 66% of the participants and "low feed-in tariffs" was the highest, not a barrier at 31%. Logistic regression on the barriers indicated that only lack of information had a statistically significant ($p = 0.015$) outcome with a coefficient (B) of -0.656, indicating a negative impact of the lack of information on residential rooftop solar PV systems to adoption.

Logistic regression supported Hypotheses 1, 3, and 4, but not Hypothesis 2. However, the small sample size limited hypothesis testing and overall results. Findings suggest that adoption is not driven by a single factor but by a more complex decision process involving multiple factors.

CHAPTER 5. DISCUSSION OF THE RESULTS

5.1 Introduction

This chapter provides the discussion on the findings of the study within the context of the literature review. The chapter will discuss the demographics of the respondents and their adoption profile, then focus on discussions on the hypothesis 1 to hypothesis 4 of the study. Lastly, provide a summary the chapter.

5.2 Demographic profile of respondents

The majority (70.7%) of the 140 participants had residential rooftop solar PV systems installed indicating a bias towards those who have already adopted wanting to participate in the study. Self-selection bias is where participants who have already adopted the technology are more likely to take part in the study compared to non-adopters (Murdoch et al., 2014).

Rogers' characterisation of adopters indicates that there is no age difference between early adopters and early majority (Rogers, 2003). The findings from this study were that the mean age was 46 for both those who have installed and those who have not installed.

Literature argues that age and gender can affect attitudes towards solar PV adoption as older individuals and females may show more reluctance towards adopting PV systems due to traditional lifestyle preferences and societal expectations (Deng et al., 2024; Wang et al., 2024). While a higher proportion of female respondents (72.9%) reported solar PV adoption compared to males (67.3%), it is unclear whether this reflects women-led household decisions or simply that more women responded to the survey.

It is argued that income is a significant predictor of residential PV adoption, with higher incomes generally leading to higher adoption rates (Deng et al., 2024). Education level can influence adoption, although its impact is less consistent but generally, higher education levels are sometimes associated with higher adoption rates (Deng et al., 2024).The findings of this study were that the income levels for both adopter groups and the education levels had similar profiles

5.3 Discussion pertaining to Hypothesis 1

According to Rogers' diffusion of innovations theory, the literature proposes general profiles for each adopter category, taking into account their socioeconomic characteristics, media usage, and personality variables (Menon & Sujatha, 2021; Rogers, 2003).

Hypothesis 1: *There is no demographic difference between the Early Adopters and the Early Majority.*

Rogers (2003) argues that the innovators and early adopters tend to have more formal years of education and a greater knowledge of the technology. Rogers (2003) further provides generalisations regarding socioeconomic characteristics such as no difference between the early adopter and early majority in terms of age, but early adopters have higher education and income status .

Rogers’ diffusion of innovations theory generalisations regarding socioeconomic characteristics of adopters is consistent with findings from existing studies which indicated that wealthier, more educated, having larger households or homes and younger households are more likely to adopt residential solar PV systems (Bondio et al., 2018; Petrovich et al., 2019; Rai & Beck, 2015; Wolske & Stern, 2018).

However, some critics contend that the theory does not adequately address cultural and contextual factors that can significantly influence the adoption of innovations (Simpson & Clifton, 2017). It is argued that the diffusion of innovations is not solely determined by individual traits, but also by broader societal, economic, and political forces (Mutumbi et al., 2022; Simpson & Clifton, 2017). As such, the theory's focus on individual and interpersonal factors may neglect the broader structural and systemic influences that play a crucial role in the adoption and spread of innovations within a social system.

The findings as shown in **Table 11** indicate that gender (B = -0.253), occupation (B = - 0.248), and monthly household income (B = - 0.153) had a negative relationship indicated by the coefficient (B) with the adoption decision, while age (B = 0.020), education level (B = 0.211), size of household (B = 0.331) had a positive relationship with the adoption decision. However, none of these factors were statistically significant ($p < 0.05$) between the two groups and the conclusion being that there was no demographic difference between the two adopter groups. Thus, proving the hypothesis and the null hypothesis being rejected.

While these findings supported the hypothesis that there was no demographic difference between the early adopters and the early majority, the findings further support the argument that categorisation of adopters based on their demographics is not an accurate measure of innovativeness as socioeconomic factors only partially explained the adoption decision (Petrovich et al., 2019; Wolske, 2020).

The findings on the beliefs as presented in **Table 5** indicated little differences on the green initiatives participants had in place, with Energy saving light bulbs and Gas stove as the most initiatives in place. The logistic regression on the attitudes in **Table 8** had two statistically significant attitudes, "there is a low level of feed-in tariffs" with a coefficient (B) of 0.839 ($p = 0.005$) and "Solar systems are an affordable technology" with a coefficient (B) of 0.529 ($p = 0.037$).

The differences in the attitudes pertaining to the feed-in tariffs and the affordability of the system could explain financial or economic considerations as a significant factor among the participants which is consistent with literature that the economic considerations can greatly influence the adoption decision (Deng et al., 2024; Petrovich et al., 2019).

The hypothesis that there was no demographic, psychographic, and motivational difference between the Early Adopters and the Early Majority was supported by the personal circumstances, beliefs and majority of the attitudes (14/16).

5.4 Discussion pertaining to Hypothesis 2

Through Small-Scale Embedded Generation schemes, consumers are offered an opportunity to sell back excess electricity produced in their residential rooftop solar PV systems (O'Shaughnessy et al., 2021). Typically, feed-in tariffs are set for electricity sold which allows for shorter payback periods and may offset the high initial installation costs by offering savings over time (Dong et al., 2023; Samoita et al., 2020).

Hypothesis 2: *Feed-in tariffs significantly motivate the adoption of residential rooftop solar PV systems by providing financial incentives that enhance the perceived economic benefits and reduce the payback period for homeowners.*

Feed-in tariffs as motivators for residential rooftop solar PV adoption has been investigated in prior studies, which found a positive impact of these financial incentives on the diffusion of solar technology (Crago & Koegler, 2018; Petrovich et al., 2019). But they are not always the main driver (Curtius et al., 2018; Petrovich et al., 2019). Factors such as environmental concerns, social norms, and awareness also play a significant role in the adoption decision (Islam, 2014).

The findings were that 43.4% of the participants indicated that the tariffs did not affect their adoption decision at all and 18.6% indicated that the tariffs had a minor impact on their decision-making as shown in **Table 12** .

In **Table 13**, the findings indicated that the low level of feed-in tariffs were statistically significant with a coefficient (B) of 0.535, and a p-value of 0.036, indicating that a low level of feed-in tariffs increased the likelihood of adopting rooftop solar PV. While the influence of feed-in tariffs on the decision to install rooftop solar PV system were statistically significant with a coefficient (B) of -0.861, and a p-value less than 0.001, indicating that favourable feed-in tariffs offered by MES decreased the likelihood of adopting rooftop solar PV. The findings indicate that the feed-in tariffs were not the significant driver for adoption.

As Rogers outlined, other factors such as compatibility, complexity, observability, and trialability are also important in the context of solar PV adoption (Menon & Sujatha, 2021). The findings indicate that the role of SSEG policy instruments, including feed-in tariffs, needs to be examined in conjunction with these other key determinants as per literature (Dong et al., 2023; Samoita et al., 2020).

Thus, the hypothesis is not supported as the findings point to other factors influencing the adoption other than the feed-in tariffs. The hypothesis is not proved, and the null hypothesis is accepted.

5.5 Discussion pertaining to Hypothesis 3

Moore (2014) argues that in Rogers (2003) *Diffusion of Innovations* theory, exists gaps between the different adopter groups influencing their adoption behaviour and emphasises that a bigger gap exists between the Early Adopters and the Early Majority which he defines as the chasm.

Hypothesis 3: *A chasm exists between the Early Adopters and the Early Majority.*

It is argued that the adoption rate of technology may be slow or never occur in the early majority if the technology lacks characteristics that appeal to this adopter group (Palm, 2020). The early majority seeks simple, cost-effective technology that solves their challenges (Moore, 2014).

The findings on the motivators for adoption indicate that power reliability is ranked highest (mean = 1.66), followed by Economic benefits (mean = 2.01), then Environmental concerns (mean = 3.00), followed by Technological interests (mean = 3.72) and lastly, Social influence (mean = 4.61) as shown in **Table 14**.

It was further established through a Friedman test that there were statistical differences in the ranking of the motivators. While the Pairwise comparison (Dunn-Bonferroni test) indicated that the comparisons between the motivators had significant differences except for the non-significant comparison between power reliability and economic benefits as shown in **Table 15**. Power Reliability and Economic Benefits were both highly important motivators which ranked higher than other factors, and respondents did not significantly differentiate between them ($p > 0.05$).

The logistic regression analysis of the variables revealed that "Power Reliability" was statistically significant with a coefficient (B) of 0.462, and a p-value of 0.005, indicating that improved power reliability as a factor increased the likelihood of adopting rooftop solar PV. However, "Economic Benefits" were not statistically significant, with a coefficient (B) of -0.055 and a p-value (Sig.) of 0.848.

The *whole product* has to provide a compelling reason for the target customer to invest in the technology, this implies that the technology must have recognisable quality, proven reliability of service and fit within a supporting infrastructure of products and systems to meet the customer needs holistically (Faiers & Neame, 2006; Moore, 2014).

It is argued that crossing the chasm requires addressing a diverse set of factors beyond just financial incentives such as diffusion of information, social influences, and infrastructure reliability (Bondio et al., 2018; Islam, 2014; Karakaya et al., 2015; Petrovich et al., 2019). At the same time, relative advantage, reliability, compatibility, trialability of residential rooftop solar PV systems against power reliability can assist in bridging the chasm (Islam, 2014; Petrovich et al., 2019; Simpson & Clifton, 2017).

The installation age profile in **Figure 20** together with the findings on the power reliability, indicated that a chasm exists and was bridged by the technology as it offered proven reliability of service and fit within a supporting infrastructure of products and systems to meet the customer needs holistically (Faiers & Neame, 2006; Moore, 2014).

The hypothesis that there exists a chasm is supported by the findings and the null hypothesis is thus rejected.

5.6 Discussion pertaining to Hypothesis 4

South Africa's households have been dealing with frequent instances of load-shedding, due to the demand for electricity exceeding supply (Inglesi-Lotz, 2023). According to Eskom, failure to implement loadshedding could lead to national grid instability (Inglesi-Lotz, 2023).

Hypothesis 4*: Frequent power outages due to loadshedding significantly accelerate the adoption of residential rooftop solar PV systems by enhancing the perceived relative advantage and compatibility of the technology, thereby facilitating the transition from early adopters to the early majority as described by Rogers' Diffusion of Innovations theory and Moore's Crossing the Chasm theory.*

According to Rogers' diffusion of innovations theory, relative advantage, reliability, compatibility, and trialability are important characteristics that influence the rate of adoption of new technologies such as residential rooftop solar PV systems (Rogers, 2003). When adopters see a clear relative advantage, in terms of cost savings, energy security, or environmental benefits, over their current energy source, they are more likely to adopt the new technology (Karakaya et al., 2015; Wolske, 2020).

Literature argues against this and shows that the "early majority" can be persuaded to adopt solar PV systems through appropriate marketing and educational campaigns that address their concerns about the technology's financial and aesthetic characteristics (Menon & Sujatha, 2021; Wolske, 2020).

The findings from this study found that 50.6% of those who have installed residential rooftop solar PV systems indicated that they would not have installed the systems if there was no loadshedding. In contrast only 39.5% of those who have not installed the systems indicated that they would not consider installing the residential rooftop solar PV systems if there was no loadshedding.

The findings suggest that both adopter categories recognise the relative advantage of installing the system. The majority of those who have installed recognise the relative advantage of providing energy security, while the majority of those who have not installed recognise other advantages of installing the system other than energy security alone. It is argued that households with lower reliability of the grid power supply are more inclined to adopt solar PV to ensure energy security and increased resilience (Navidi et al., 2023; O'Shaughnessy et al., 2021).

The logistic regression analysis of the variables revealed that "Power Reliability" was statistically significant with a coefficient (B) of 0.469, and a p-value of 0.004, indicating that improved power reliability as a factor increased the likelihood of adopting rooftop solar PV as shown in table, thus supporting the hypothesis that frequent power outages due to loadshedding significantly accelerate the adoption of residential rooftop solar PV systems by enhancing the perceived relative advantage and compatibility of the technology. The hypothesis t is supported by the findings and the null hypothesis is thus rejected.

5.7 Conclusion

The findings on the gender of participants were found to be inconsistent with literature review on females being less likely to adopt solar PV systems. However, the findings were consistent on the age of the early adopters and early majority being the same. In terms of education status and income levels, the findings were inconsistent with literature as they indicated similar levels.

Hypothesis 1 was largely supported by the findings of this study that there was no demographic difference between the early adopters and early majority having assessed personal circumstances (age, gender, education level, household size, occupation and household monthly income), beliefs and attitudes towards solar PV.

Hypothesis 2 was not supported by the findings of this study as the effect of feed-in tariffs were expected to have a positive impact on adoption decision in line with literature. Thus, the hypothesis was not supported as the findings point to other factors influencing the adoption other than the feed-in tariffs.

Hypothesis 3 was supported by the findings based on the installation age profile and the findings on the power reliability. Solar PV technology bridged the chasm as it offered proven reliability of service and fitted within adopters' infrastructure. The hypothesis that there exists a chasm is supported by the findings.

Hypothesis 4 was supported by the findings that both adopter categories recognise the relative advantage of installing the system. Those who have installed recognise the relative advantage of providing energy security, while those who have not installed recognised other advantages of installing the system other than energy security alone.

5.8 Comparison of literature review and own findings

Table 18. Comparison of literature review and findings

RQ #	Research Question	Hyp #	Hypothesis	Findings from own study
1	What are the personal circumstances, beliefs and attitudes that motivate towards the adoption of residential rooftop solar PV systems?	1	There is no demographic, psychographic, and motivational difference between the Early Adopters and the Early Majority.	There are no demographic, psychographic, and motivational differences, and no significant differences in beliefs and most attitudes except for economic considerations (feed-in tariffs and high initial costs of the system.

RQ #	Research Question	Hyp #	Hypothesis	Findings from own study
2	To what extend does the small scale embedded generation (SSEG) buy back tariff encourage or deter the purchasing of a residential rooftop solar PV system?	2	Feed-in tariffs significantly motivate the adoption of residential rooftop solar PV systems by providing financial incentives that enhance the perceived economic benefits and reduce the payback period for homeowners.	Feed-in tariffs have little motivation on the adoption instead other factors are more important to the decision making.
3	Has load shedding led to an increase in residential rooftop solar PV systems adoption?	3	There is a chasm between the Early Adopters and the Early Majority.	A chasm exists between the early adopters and the early majority
		4	Frequent power outages due to loadshedding significantly accelerate the adoption of residential rooftop solar PV systems by enhancing the perceived relative advantage and compatibility of the technology, thereby facilitating the transition from early adopters to the early majority.	Power reliability is a significant motivator and improved power reliability increases the likelihood of adopting rooftop solar PV

CHAPTER 6. CONCLUSIONS & RECOMMENDATIONS

6.1 Introduction

This study examined the factors influencing households' adoption of rooftop solar PV systems in an upmarket residential estate in Gauteng, South Africa, using Rogers' Diffusion of Innovation theory and Moore's technology adoption life cycle as the guiding framework. The research problem was motivated by South Africa's electricity challenges, including rising tariffs, load shedding, and the environmental impact of coal-based generation. While rooftop solar PV is increasingly adopted in higher-income households, there is limited evidence on the intrinsic and extrinsic factors that shape these decisions in the local context.

To address this gap, a quantitative descriptive design was employed, utilising a self-administered questionnaire distributed to residents of Midstream Estates. Descriptive statistics and logistic regression were used to test the relationship between adoption decisions and demographic, financial, attitudinal, and contextual factors. The study provides policymakers, municipalities, financial institutions, and solar providers with valuable insights into the drivers of residential adoption, enabling them to develop targeted strategies. This chapter presents the conclusions, recommendations, and areas for further research.

6.2 Conclusions regarding research question 1

Findings on Research Question 1: What are the personal circumstances, beliefs and attitudes that motivate towards the adoption of residential rooftop solar PV systems?

The study confirmed that the personal circumstances in terms of age, gender, education level, household size, occupation and household monthly income were not different between participants who had adopted rooftop solar PV systems and those who had not. Thus, the personal circumstances had no impact on the adoption of residential rooftop solar PV systems.

The beliefs of the participants as measured by the green initiatives they had in place highlighted a similar trend between those who had adopted residential rooftop solar PV systems and those who had not. While there were differences, they were not scientifically significant and had no impact on the adoption of residential rooftop solar PV systems.

The attitudes towards residential rooftop solar PV systems were the same for 14 of the 16 attitudes tested and the significant difference was on "there is a low level of feed-in tariffs" and "Solar systems are an affordable technology". The differences explain economic considerations which had an impact on the adoption of residential rooftop solar PV systems.

6.3 Conclusions regarding research question 2

Findings on Research Question 2: To what extend does the small-scale embedded generation (SSEG) buy back tariff encourage or deter the purchasing of a residential rooftop solar PV system?

The study found that participants, regardless of whether they had installed rooftop solar PV systems, generally perceived the level of feed-in tariffs offered by MES as being too low to influence their adoption decisions significantly. Statistical analysis confirmed a significant relationship between feed-in tariffs and adoption decisions; however, the relationship was negative, suggesting that the tariffs, in their current form, reduce the likelihood of adoption.

The negative relationship does not imply that higher tariffs would discourage adoption. Instead, it indicates that the current tariffs are too low to serve as an incentive. Suggesting that participants prioritised other factors (such as energy security, loadshedding, and long-term cost savings) over the tariff when deciding whether to adopt rooftop solar PV. Therefore, the SSEG buy-back tariff, at its present low level, neither encourages nor significantly deters residential rooftop solar PV adoption.

6.4 Conclusions regarding research question 3

Findings on Research Question 3: Has load shedding led to an increase in residential rooftop solar PV systems adoption?

The results of the study indicated an increase in adoption during the period of increased unreliable power supply from the grid. Furthermore, the results of the study indicated power reliability ranked as the highest motivator for adoption. However, amongst the participants who had adopted and not adopted, power reliability and economic benefits had a non-significant comparison. This indicates that some participants consider both as important in their decision-making. It was further established through the results statistically that improved power reliability increased the likelihood of adoption for rooftop solar PV.

6.5 Limitations of Hypothesis Testing

Although a sample size of 362 respondents was calculated as necessary to achieve a 95% confidence level and a 5% margin of error, only 153 responses were obtained, of which 140 were valid. This resulted in a margin of error of 8.19%, which is higher than the desired 5%, thereby reducing the statistical power of the hypothesis testing. Consequently, the findings cannot be regarded as conclusive or generalisable to the entire Midstream Estate population.

The descriptive statistics provided valuable insights into emerging patterns and potential relationships; however, they must be interpreted as exploratory rather than definitive. Further research with a larger and more representative sample is necessary to validate these trends and to provide more substantial evidence for the hypotheses tested in this study.

Table 19. Consistency table: research questions, conclusions and contribution to knowledge

RQ #	State Research Question or Objective	State literature-based proposition or hypothesis	State conclusion or answer based on own research	Highlight key differences between your initial propositions / hypotheses and your findings – this is your contribution to knowledge
1	What are the personal circumstances, beliefs and attitudes that motivate towards the adoption of residential rooftop solar PV systems?	There is no demographic, psychographic, and motivational difference between the Early Adopters and the Early Majority.	There personal circumstances and beliefs are the same for those who have adopted and those who have not. However, the attitudes differ on high initial costs of solar PV systems and low feed-in tariffs.	Attitude towards the economic considerations is different between those who have adopted and those who have not.
2	To what extend does the small-scale embedded generation (SSEG) buy back tariff encourage or deter the purchasing of a residential rooftop solar PV system?	Feed-in tariffs significantly motivate the adoption of residential rooftop solar PV systems by providing financial incentives that enhance the perceived economic benefits and reduce the payback period for homeowners.	Feed-in tariffs have little motivation on the adoption instead other factors are more important to the decision making	Other factors were more important in the adoption decision-making process other than existence of the feed-in tariffs nor the level of the feed-in tariffs.

RQ #	State Research Question or Objective	State literature-based proposition or hypothesis	State conclusion or answer based on own research	Highlight key differences between your initial propositions / hypotheses and your findings – this is your contribution to knowledge
3	Has load shedding led to an increase in residential rooftop solar PV systems adoption?	There is a chasm between the Early Adopters and the Early Majority.	A chasm exists between the early adopters and the early majority	The results confirm that a chasm exists and has resulted in increased adoption.
		Frequent power outages due to loadshedding significantly accelerate the adoption of residential rooftop solar PV systems by enhancing the perceived relative advantage and compatibility of the technology, thereby facilitating the transition from early adopters to the early majority.	Power reliability is a significant motivator and improved power reliability increases the likelihood of adopting rooftop solar PV	The effect of higher loadshedding has been an increase in adoption during the same period as the relative advantage of solar PV systems for reliable power supply increases. Indicating a positive relationship between power reliability and adoption decision.

6.6 Recommendations

The study provides further insights to policy makers, municipalities, researchers, financial institutions, and solar PV service providers on the influence demographics, beliefs, attitudes and external factors such as feed-in tariffs and impact of loadshedding on adoption of residential rooftop solar PV systems.

The findings of the study highlight that personal circumstances have minimal impact on the adoption decision making process while highlighting low levels of beliefs in green initiatives. The participants attitudes indicate that economic concerns of the systems need to be addressed.

It is recommended that policy makers, municipalities and solar PV service providers increase awareness of energy savings to improve economic benefits and evaluate feed-in tariff structures and the associated SSEG policies. Together with financial institutions, seek to develop financial schemes that will improve adoption for its overall benefits not only because of current unreliable power supply.

6.7 Suggestions for further research

Further evaluation of the economic considerations and power reliability is required with a larger sample size to understand the effect of size. Additionally, a mixed-method study that will allow the researcher to probe deeper.

The study was confined to a similar LSM and provides insights on adoption but a similar study across different LSM groups will further improve insights into the adoption decision-making.

Given the complex decision-making process for adoption, additional research on other factors such as social influence, psychological factors, technical and contextual conditions can be carried out.

REFERENCES

Abutabenjeh, S., & Jaradat, R. (2018). Clarification of research design, research methods, and research methodology: A guide for public administration researchers and practitioners. *Teaching Public Administration, 36*(3), 237-258.

Akaranga, S. I., & Makau, B. K. (2016). Ethical considerations and their applications to research: A case of the University of Nairobi. *Journal of educational policy and entrepreneurial research, 3*(12), 1-9.

Albert, J., Rizzo, M., Albert, J., & Rizzo, M. (2012). Regression. *R by Example: Concepts to Code*, 173-197.

Alifia, T., & Fraser, K. (2021). Achieving renewable energy targets: The impact of residential solar PV prosumers in Indonesia. *International Journal of Sustainable Energy Planning and Management, 32*, 111-124.

Alipour, M., Salim, H., Stewart, R. A., & Sahin, O. (2020, 2020/05/01/). Predictors, taxonomy of predictors, and correlations of predictors with the decision behaviour of residential solar photovoltaics adoption: A review. *Renewable and Sustainable Energy Reviews, 123*, 109749. https://doi.org/https://doi.org/10.1016/j.rser.2020.109749

Alipour, M., Salim, H., Stewart, R. A., & Sahin, O. (2021, 2021/06/01/). Residential solar photovoltaic adoption behaviour: End-to-end review of theories, methods and approaches. *Renewable Energy, 170*, 471-486. https://doi.org/https://doi.org/10.1016/j.renene.2021.01.128

Alrawi, O. F., Al-Siddiqi, T., Al-Muhannadi, A., Al-Siddiqi, A., & Al-Ghamdi, S. G. (2022, 2022/06/01/). Determining the influencing factors in the residential rooftop solar photovoltaic systems adoption: Evidence from a survey in Qatar. *Energy Reports, 8*, 257-262. https://doi.org/https://doi.org/10.1016/j.egyr.2022.01.064

Andreoni, A., Creamer, K., Mazzucato, M., & Steyn, G. (2022). How can South Africa advance a new energy paradigm? A mission-oriented approach to megaprojects. *Oxford Review of Economic Policy, 38*(2), 237-259.

Austin, Z., & Sutton, J. (2014). Qualitative research: Getting started. *The Canadian journal of hospital pharmacy, 67*(6), 436.

Awuku, S. A., Bennadji, A., Muhammad-Sukki, F., Prabhu, R., & Sellami, N. (2023). Assessment of Awareness and Willingness to Adopt Solar Energy in Ghana–Perspective from End Users.

Bohlmann, J. A., & Inglesi-Lotz, R. (2018). Analysing the South African residential sector's energy profile. *Renewable and Sustainable Energy Reviews, 96*, 240-252.

Bondio, S., Shahnazari, M., & McHugh, A. (2018, 2018/10/01/). The technology of the middle class: Understanding the fulfilment of adoption intentions in Queensland's rapid uptake residential solar photovoltaics market. *Renewable and Sustainable Energy Reviews, 93*, 642-651. https://doi.org/https://doi.org/10.1016/j.rser.2018.05.035

Boshoff, T. (2024). Underwhelming Integrated Resource Plan has to harness the potential of the private sector. *Farmer's Weekly, 2024*(24008), 14-14.

Bowman, A. (2020). Parastatals and economic transformation in South Africa: The political economy of the Eskom crisis. *African Affairs, 119*(476), 395-431.

Bradburn, N. M., Sudman, S., Blair, E., & Stocking, C. (1978). Question threat and response bias. *Public opinion quarterly, 42*(2), 221-234.

Bush, D. W., & White, K. R. (1985). Questionnaire distribution: A method that significantly improved return rates. *Psychological reports, 56*(2), 427-430.

Chakraborty, P., Baeyens, E., Khargonekar, P. P., Poolla, K., & Varaiya, P. (2018). Analysis of solar energy aggregation under various billing mechanisms. *IEEE Transactions on Smart Grid, 10*(4), 4175-4187.

Chatterjee, S., & Hadi, A. S. (2015). *Regression analysis by example*. John Wiley & Sons.

Choi, B. C., & Pak, A. W. (2005, Jan). A catalog of biases in questionnaires. *Prev Chronic Dis, 2*(1), A13.

Clark, S., McGregor, C., & van Niekerk, J. (2022). Using liquefied petroleum gas to reduce the operating cost of the Ankerlig peaking power plant in South Africa. *Journal of Energy in Southern Africa, 33*(2), 15-23.

Crago, C. L., & Koegler, E. (2018, 2018/09/01/). Drivers of growth in commercial-scale solar PV capacity. *Energy Policy, 120*, 481-491. https://doi.org/https://doi.org/10.1016/j.enpol.2018.05.047

Curtius, H. C., Hille, S. L., Berger, C., Hahnel, U. J. J., & Wüstenhagen, R. (2018, 2018/07/01/). Shotgun or snowball approach? Accelerating the diffusion of rooftop solar photovoltaics through peer effects and social norms. *Energy Policy, 118*, 596-602. https://doi.org/https://doi.org/10.1016/j.enpol.2018.04.005

Deng, X., Poletti, S., Hazledine, T., Tao, M., & Sbai, E. (2024, 2024/12/01/). Deploying solar photovoltaic through subsidies: An Australian case. *Journal of Environmental Management, 372*, 123293. https://doi.org/https://doi.org/10.1016/j.jenvman.2024.123293

Department of Energy. (2019). *The South African Energy Sector Report 2019*. D. o. Energy. http://www.energy.gov.za/files/media/explained/2019-South-African-Energy-Sector-Report.pdf

Department of Energy. (2021). *Aggregate energy balances*. D. o. Energy. https://www.energy.gov.za/files/media/Energy_Balances.html

Department of Minerals and Energy. (1998). *White paper on the energy policy of the Republic of South Africa*. http://www.energy.gov.za/files/policies/whitepaper_energypolicy_1998.pdf

Department of Minerals and Energy (DMRE). (2023). *Integrated Resource Plan (IRP) 2023.* https://www.gov.za/sites/default/files/gcis_document/202401/49974gon4238.pdf

Department of Public Enterprises. (2019). *Roadmap For Eskom In A Reformed Electricity Supply Industry* (RP: 369/2019). https://www.gov.za/sites/default/files/gcis_document/201910/roadmap-eskom.pdf

Department: National Treasury. (2023). *Solar panel tax incentive for individuals*. https://www.treasury.gov.za/documents/National%20Budget/2023/2023%20Budget%20FAQs%20-%20Solar%20Panel%20Tax%20Incentive.pdf

Dong, C., Nemet, G., Gao, X., Barbose, G., Sigrin, B., & O'Shaughnessy, E. (2023, 2023/05/03). Machine learning reduces soft costs for residential solar photovoltaics. *Scientific Reports, 13*(1), 7213. https://doi.org/10.1038/s41598-023-33014-4

Eberhard, A., & Mtepa, M. (2003). Rationale for restructuring and regulation of a 'low priced'public utility: a case study of Eskom in South Africa. *International Journal of Regulation and Governance, 3*(2), 77-102.

Ebhota, W. S., & Tabakov, P. Y. (2022). Assessment of solar PV potential and performance of a household system in Durban North, Durban, South Africa. *Clean Technologies and Environmental Policy, 24*(4), 1241-1259.

Erero, J. L. (2023). Impact of loadshedding in South Africa: A CGE analysis. *Journal of Economics and Political Economy, 10*(2), 78-94.

Eskom. (2017). *Strategic direction and tariff design principles for Eskom's tariffs* https://www.eskom.co.za/distribution/wp-content/uploads/2021/06/StrategicPricingDirection2017.pdf

Eskom. (2021). *Eskom 2021 Integrated Report*. https://www.eskom.co.za/wp-content/uploads/2021/08/2021IntegratedReport.pdf

Eskom. (2023). *Eskom Retail Tariff Plan*.

Faiers, A., & Neame, C. (2006). Consumer attitudes towards domestic solar power systems. *Energy Policy, 34*(14), 1797-1806.

Fauzi, M. A., Abidin, N. H. Z., Suki, N. M., & Budiea, A. M. A. (2023). Residential rooftop solar panel adoption behavior: Bibliometric analysis of the past and future trends. *Renewable Energy Focus*.

Goliger, A., & Cassim, A. (2018). Household tipping points in the face of rising electricity tariffs1. *Competition and Regulation for Inclusive Growth in Southern Africa*, 249.

Grimm, P. (2010). Social Desirability Bias. In *Wiley international encyclopedia of marketing*. https://doi.org/https://doi.org/10.1002/9781444316568.wiem02057

IEA. (2021). *World Energy Balances: Overview*. https://www.iea.org/reports/world-energy-balances-overview

IEA. (2025). *Electricity generation by source, South Africa, 1990–2023* International Energy Agency. https://www.iea.org/data-and-statistics/data-tools/energy-statistics-data-browser

Inglesi-Lotz, R. (2023). Load shedding in South Africa: Another nail in income inequality? *South African Journal of Science, 119*(9-10), 1-4.

Islam, T. (2014). Household level innovation diffusion model of photo-voltaic (PV) solar cells from stated preference data. *Energy Policy, 65*, 340-350.

Jin, L. (2012, 5-7-2012). Qualitative Research Gains Equality: A Review of Research Methodology: A Step-by-Step Guide for Beginners. *The Qualitative Report, 17*(19), 1-3. https://doi.org/https://doi.org/10.46743/2160-3715/2012.1776

Kadam, P., & Bhalerao, S. (2010). Sample size calculation. *International journal of Ayurveda research, 1*(1), 55.

Karakaya, E., Hidalgo, A., & Nuur, C. (2015, 2015/03/01/). Motivators for adoption of photovoltaic systems at grid parity: A case study from Southern Germany. *Renewable and Sustainable Energy Reviews, 43*, 1090-1098. https://doi.org/https://doi.org/10.1016/j.rser.2014.11.077

Kock, Z., & Govender, K. K. (2021). Load-shedding and the Declining Energy Availability Factor: A Case Study of a South African Power Station. *Mediterranean Journal of Social Sciences, 12*(6), 128-128.

Korsten, N., Brent, A., Sebitosi, A., & Kritzinger, K. (2017). The impact of residential rooftop solar PV on municipal finances: An analysis of Stellenbosch. *Journal of Energy in Southern Africa, 28*(2), 29-39.

Kritzinger, K., & Meyer, I. (2015). Solar photovoltaic research: Drakenstein Municipality. *Dialogue, 1*, 2.

Kurdgelashvili, L., Shih, C.-H., Yang, F., & Garg, M. (2019). An empirical analysis of county-level residential PV adoption in California. *Technological Forecasting and Social Change, 139*, 321-333.

Labuschagne, H. (2020). *Eskom electricity prices – 1994 to 2020*. Mybroadband. Retrieved 22 June 2022 from https://mybroadband.co.za/news/energy/362660-eskom-electricity-prices-1994-to-2020.html

Mabunda, N. E. (2021). Use of Photovoltaic Energy to Minimize the Impact of Load-shedding in South Africa. 2021 International Conference on Electrical, Computer and Energy Technologies (ICECET),

Mahn, D., Best, R., Wang, C., & Abiona, O. (2024). What drives solar energy adoption in developing countries? Evidence from household surveys across countries. *Energy Economics, 138*, 107815.

Mampa, K., & Alonge, A. (2021). Probabilistic distributions for modelling seasonal load profiles of commercial areas in South Africa. 2021 IEEE AFRICON,

Mantlana, K. B., Maoela, M. A., & Nhamo, G. (2021). Mapping South Africa 's nationally determined contributions to the targets of the sustainable development goals. Natural Resources Forum,

Mbomvu, L., Hlongwane, I. T., Nxazonke, N. P., Qayi, Z., & Bruwer, J.-P. (2021). Load shedding and its influence on South African Small, Medium and Micro Enterprise profitability, liquidity, efficiency and solvency. *Business Re-Solution Working paper BRS/2021/001*.

McEwan, B. (2020). Sampling and validity. *Annals of the International Communication Association, 44*(3), 235-247.

McKay, T., & Hendricks, D. (2022). Pitiful rooftop solar uptake in sunny South Africa: a policy, funding and service delivery perspective. *Frontiers in Sustainable Cities, 4*, 969040.

Mehra, B. (2002). Bias in qualitative research: Voices from an online classroom. *The Qualitative Report, 7*(1), 1-19.

Menon, N. M., & Sujatha, I. (2021). Influence of Rogers' theory of innovation of diffusion on customer's purchase intention–a case study of solar photovoltaic panels. IOP Conference Series: Materials Science and Engineering,

Moodliar, L., & Davidson, I. E. (2024). South Africa's Solar Rebates: Hope or Hate for Residential Customers Within eThekwini Municipality. In Z. Peng (Ed.), *Trends and Technological Challenges in Green Energy: Selected Papers from ICGET 2023* (pp. 25-35). Springer Nature Switzerland. https://doi.org/10.1007/978-3-031-55579-4_3

Moore, G. A. (2014). *Crossing the Chasm, 3rd Edition: Marketing and Selling Disruptive Products to Mainstream Customers*. HarperCollins. https://books.google.co.za/books?id=wUEHAQAAQBAJ

Mulaudzi, S. K., Bull, S., & Makhado, R. A. (2022). Potential of households' solar PV consumption in South Africa. *African Journal of Science, Technology, Innovation and Development, 14*(3), 730-739.

Murdoch, M., Simon, A. B., Polusny, M. A., Bangerter, A. K., Grill, J. P., Noorbaloochi, S., & Partin, M. R. (2014). Impact of different privacy conditions and incentives on survey response rate, participant representativeness, and disclosure of sensitive information: a randomized controlled trial. *BMC medical research methodology, 14*, 1-11.

Mutumbi, U., Thondhlana, G., & Ruwanza, S. (2022). The status of household electricity use behaviour research in South Africa between 2000 and 2022. *Energies, 15*(23), 9018.

Navidi, T., El Gamal, A., & Rajagopal, R. (2023). Coordinating distributed energy resources for reliability can significantly reduce future distribution grid upgrades and peak load. *Joule, 7*(8), 1769-1792.

Neves, C., Oliveira, T., Cruz-Jesus, F., & Venkatesh, V. (2025). Extending the unified theory of acceptance and use of technology for sustainable technologies context. *International Journal of Information Management, 80*, 102838.

Nkosi, N., & Govender, K. K. (2022). Electricity price increases and energy demand: the case of an electricity supplier in South Africa. *International Journal of Energy Economics and Policy, 12*(5), 138-145.

O'Shaughnessy, E., Barbose, G., Wiser, R., Forrester, S., & Darghouth, N. (2021, 2021/01/01). The impact of policies and business models on income equity in rooftop solar adoption. *Nature Energy, 6*(1), 84-91. https://doi.org/10.1038/s41560-020-00724-2

Palm, A. (2020). Early adopters and their motives: Differences between earlier and later adopters of residential solar photovoltaics. *Renewable and Sustainable Energy Reviews, 133*, 110142.

Palmer, P. B., & O'Connell, D. G. (2009, Sep). Regression analysis for prediction: understanding the process. *Cardiopulm Phys Ther J, 20*(3), 23-26.

Pandarum, A., Lekoloane, G. A., & Milazi, D. B. (2019). Trends and statistics of solar PV distributed generation in South Africa. In. Alive2Green.

Pathania, A. K., Goyal, B., & Saini, J. R. (2017). Diffusion of adoption of solar energy–a structural model analysis. *Smart and Sustainable Built Environment, 6*(2), 66-83.

Petrovich, B., Hille, S. L., & Wüstenhagen, R. (2019, 2019/10/01/). Beauty and the budget: A segmentation of residential solar adopters. *Ecological Economics, 164*, 106353. https://doi.org/https://doi.org/10.1016/j.ecolecon.2019.106353

Pierce, W., & Le Roux, M. (2023). *Statistics of utility-scale power generation in South Africa in 2022*

Qeqe, B., Kapingura, F., & Mgxekwa, B. (2022). The relationship between electricity prices and household welfare in South Africa. *Energies, 15*(20), 7794.

Ragab, M. A., & Arisha, A. (2018). Research methodology in business: A starter's guide.

Rai, V., & Beck, A. L. (2015). Public perceptions and information gaps in solar energy in Texas. *Environmental Research Letters, 10*(7), 074011.

Ranganathan, P., & Caduff, C. (2023). Designing and validating a research questionnaire-Part 1. *Perspectives in Clinical Research, 14*(3), 152-155. https://doi.org/https://doi.org/10.4103/picr.picr_140_23

Richards, M., & Stolp, J. (2021). *New 100MW licensing threshold for embedded generation creates opportunities for self-generation*. White & Case LLP. Retrieved 13 June 2022 from https://www.whitecase.com/publications/alert/new-100mw-licensing-threshold-embedded-generation-creates-opportunities-self

Richards, N. D. M. (2023). Beyond resistance? Exploring dynamics of incumbency in South Africa's power sector reform.

Rix, R., Kritzinger, K., Meyer, I., & van Niekerk, J. (2015). Potential for distributed solar photovoltaic systems in the Western Cape Province. *Stellenbosch: Centre for Renewable and Sustainable Energy Studies, Stellenbosch University*.

Robinson, S. A., & Rai, V. (2015). Determinants of spatio-temporal patterns of energy technology adoption: An agent-based modeling approach. *Applied Energy, 151*, 273-284.

Rogers, E. M. (2003). *Diffusion of Innovations* (fifth ed.). Free Press.

SALGA. (2023). *Status of Embedded Generation in South African Municipalities*.

Samoita, D., Nzila, C., Østergaard, P. A., & Remmen, A. (2020). Barriers and Solutions for Increasing the Integration of Solar Photovoltaic in Kenya's Electricity Mix. *Energies, 13*(20), 5502. https://www.mdpi.com/1996-1073/13/20/5502

Schulte, E., Scheller, F., Sloot, D., & Bruckner, T. (2022). A meta-analysis of residential PV adoption: The important role of perceived benefits, intentions and antecedents in solar energy acceptance. *Energy Research & Social Science, 84*, 102339.

Senatla, M., Bansal, R. C., Naidoo, R., Chiloane, L., & Mudau, U. (2020). Estimating the economic potential of PV rooftop systems in South Africa's residential sector: a tale of eight metropolitan cities. *IET Renewable Power Generation, 14*(4), 506-514.

Sewchurran, S., & Davidson, I. E. (2021). Technical and financial analysis of large-scale solar-PV in eThekwini Municipality: Residential, business and bulk customers. *Energy Reports, 7*, 4961-4976.

Sewchurran, S., Davidson, I. E., & Ojo, O. (2017). Drivers, barriers and a method for evaluating the feasibility of residential rooftop solar PV in Durban (Part 1). 2017 IEEE PES PowerAfrica,

Simpson, G., & Clifton, J. (2017). Testing diffusion of innovations theory with data: financial incentives, early adopters, and distributed solar energy in Australia. *Energy Research & Social Science, 29*, 12-22.

Singh, G. K. (2013). Solar power generation by PV (photovoltaic) technology: A review. *Energy, 53*, 1-13.

Sjöström, O., & Holst, D. (2002, 2002/01/01). Validity of a questionnaire survey: response patterns in different subgroups and the effect of social desirability. *Acta Odontologica Scandinavica, 60*(3), 136-140. https://doi.org/10.1080/000163502753740133

Sommerfeld, J., Buys, L., & Vine, D. (2017). Residential consumers' experiences in the adoption and use of solar PV. *Energy Policy, 105*, 10-16.

Steenkamp, H., February, A., September, J., Taylor, A., Hollis-Turner, S., & Bruwer, J.-P. (2016). The influence of load shedding on the productivity of hotel staff in Cape Town, South Africa. *Expert Journal of Business and Management, 4*(2), 69-77.

The Presidency Republic of South Africa. (2022). *Confronting the energy crisis: An action plan to end load shedding*. https://www.gov.za/documents/confronting-energy-crisis-action-plan-end-load-shedding-25-jul-2022-0000

The World Bank. (2019). *World Development Indicators* https://data.worldbank.org/indicator/EG.ELC.ACCS.ZS?locations=ZG-ZA

The World Bank. (2023). Access to electricity (% of population) - South Africa. https://data.worldbank.org/indicator/EG.ELC.ACCS.ZS?locations=ZA

Thopil, G. A. (2021). The Evolution of Electrification in South Africa and Its Energy-Environmental Impact. In *Energy and Environmental Security in Developing Countries* (pp. 253-278). Springer.

Ting, M. B., & Byrne, R. (2020). Eskom and the rise of renewables: Regime-resistance, crisis and the strategy of incumbency in South Africa's electricity system. *Energy Research & Social Science, 60*, 101333.

Uhunamure, S. E., & Shale, K. (2021). A SWOT Analysis approach for a sustainable transition to renewable energy in South Africa. *Sustainability, 13*(7), 3933.

Vasseur, V., & Kemp, R. (2015a). The adoption of PV in the Netherlands: A statistical analysis of adoption factors. *Renewable and Sustainable Energy Reviews, 41*, 483-494.

Vasseur, V., & Kemp, R. (2015b). A segmentation analysis: the case of photovoltaic in the Netherlands. *Energy Efficiency, 8*, 1105-1123.

Wang, S., Feng, T., Fan, S., & Balezentis, T. (2024, 2024/12/10/). Traversing the Jevons Paradox: The dual role of residential photovoltaic systems in electricity conservation and increased consumption in an emerging economy. *Journal of Cleaner Production, 483*, 144264. https://doi.org/https://doi.org/10.1016/j.jclepro.2024.144264

Wentzel, J. P., Diatha, K. S., & Yadavalli, V. S. S. (2016). An investigation into factors impacting financial exclusion at the bottom of the pyramid in South Africa. *Development Southern Africa, 33*(2), 203-214.

Wolske, K. S. (2020, 2020/05/01/). More alike than different: Profiles of high-income and low-income rooftop solar adopters in the United States. *Energy Research & Social Science, 63*, 101399. https://doi.org/https://doi.org/10.1016/j.erss.2019.101399

Wolske, K. S., & Stern, P. C. (2018). 6 - Contributions of psychology to limiting climate change: Opportunities through consumer behavior. In S. Clayton & C. Manning (Eds.), *Psychology and Climate Change* (pp. 127-160). Academic Press. https://doi.org/https://doi.org/10.1016/B978-0-12-813130-5.00007-2

Wu, W., & Little, T. D. (2011). Quantitative Research Methods. In B. B. Brown & M. J. Prinstein (Eds.), *Encyclopedia of Adolescence* (pp. 287-297). Academic Press. https://doi.org/https://doi.org/10.1016/B978-0-12-373951-3.00034-X

Yin, R. K. (2017). *Case study research and applications*. SAGE Publications US.

Zohreh, S., & Martin, W. F. P. (2017). Validity in Rehabilitation Research: Description and Classification. In T. Uner (Ed.), *Physical Disabilities* (pp. Ch. 1). IntechOpen. https://doi.org/10.5772/67389

Žukauskas, P., Vveinhardt, J., & Andriukaitienė, R. (2018). Structure of Research Design: Expert Evaluation. *Management Culture and Corporate Social Responsibility*.

Zyphur, M. J., & Pierides, D. C. (2017). Is quantitative research ethical? Tools for ethically practicing, evaluating, and using quantitative research. *Journal of Business Ethics, 143*, 1-16.

APPENDIX A – Research Instrument

Introduction

Thank you for agreeing to participate in this study and taking your time to complete this questionnaire which should take about 10 minutes of your time. I am a Masters in Management in Energy Leadership student at the University of the Witwatersrand (Wits Business School) and this research project is part of the requirements for successful completion of the programme.

The study aims to evaluate factors influencing households' purchase of rooftop solar photovoltaics in an upmarket secure residential estate in Gauteng province, South Africa. The results of this research project will be published by Wits Business School (WBS).

Informed Consent

Your participation in this survey is voluntary and you may withdraw at any time. By completing the survey, you indicate that you voluntarily participate in this research. All data collected during this research will be kept strictly confidential and participants will remain anonymous. Any contact details obtained during this study will be kept confidential and not solicited to anyone. You may seek clarification or access to a summary of the results by requesting them from me or my research supervisor on the details provided below.

Researcher: Lucky Mogashana
Email: 2391688@students.wits.ac.za

Supervisor: Prof. Lwazi Ngubevane
Email: lwazi.ngubevana@wits.ac.za

By clicking the button below, you acknowledge:

- Your participation in the study is voluntary.
- You are 18 years of age or older.
- You are aware that you may choose to terminate your participation at any time for any reason.

○ I consent, begin the study

○ I do not consent, I do not wish to participate

Skip To: End of Survey If QID172807553 = I do not consent, I do not wish to participate

End of Block: Informed Consent

Start of Block: Solar Adoption

Q1 Do you have a rooftop solar photovoltaic system installed in your home?

◯ Yes

◯ No

1. *Display This Question:*
    2. *If Do you have a rooftop solar photovoltaic system installed in your home? = No*

Q2 Which option best describes why you have not installed solar PV system in your home?

◯ I have never thought about it

◯ I am thinking about it

◯ I thought about it and decided against it

End of Block: Solar Adoption

Start of Block: PART 1: Demographics

Q1 What is your gender?

◯ Male

◯ Female

Q2 In what year were you born?

Please select the year in which you were born	▼ 1900 ... 2049

Q3 What is the highest level of education you have completed?

- ○ Primary School
- ○ Martic
- ○ Artisan Certificate
- ○ Diploma
- ○ University degree
- ○ Postgraduate degree
- ○ Other

Q4 How many people live in your household?

- 1
- 2
- 3
- 4
- 5 or more

Q5 What is your occupation?

- Student
- Employed (Full-time)
- Employed (Part-time)
- Self-employed
- Unemployed
- Retired
- Other (Please specify)

3. *Display This Question:*
    4. *If What is your occupation? = Other (Please specify)*

Q5a Please specify the occupation ____

Q6 Please indicate the category which best describes your monthly household income?

- ○ R5,000 - R9,999
- ○ R10,000 - R24,999
- ○ R25,000 - R39,999
- ○ R40,000 - R59,999
- ○ R60,000 - R79,999
- ○ R80,000 - R99,999
- ○ R100,000 - R149,999
- ○ R150,000 or more

Q7 Does your house have any of the following: (you can select more than one option)

- ☐ Roof insulation
- ☐ Energy saving light bulbs (e.g. LED light)
- ☐ Automatic light switches
- ☐ Geyser blanket
- ☐ Solar Geyser
- ☐ Geyser timer

- [ ] Water saving taps and shower heads
- [ ] Gas heating
- [ ] Gas stove
- [ ] Recycling

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5. Display This Question:

6. If Do you have a rooftop solar photovoltaic system installed in your home? = Yes

Q8 Before you installed your solar system, what did your house already have in place: (you can select more than one option)

- ☐ Roof insulation
- ☐ Energy saving light bulbs (e.g. LED light)
- ☐ Automatic light switches
- ☐ Geyser blanket
- ☐ Solar Geyser
- ☐ Geyser timer
- ☐ Water saving taps and shower heads
- ☐ Gas heating
- ☐ Gas stove
- ☐ Recycling

7. *Display This Question:*
    8. *If Do you have a rooftop solar photovoltaic system installed in your home? = No*

Q9 In the last 3 years, on average, how often did you experience power cuts / loadshedding?

- ◯ At least once a week
- ◯ At least every two weeks
- ◯ At least once a month
- ◯ At least every three months
- ◯ At least once a year
- ◯ Never

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9. Display This Question:

10. If Do you have a rooftop solar photovoltaic system installed in your home? = No

Q10 Does your house have any of the following? (You can select more than one option)

- ◯ A generator
- ◯ Battery back-up
- ◯ Uninterrupted power supply (UPS)

End of Block: PART 1: Demographics

Start of Block: PART 2: Using rooftop solar power in your home

Q13 Below are a number of statements that could describe rooftop solar energy use in the home.

For each statement, please click on the checkbox that best describes your feelings towards the statement.

	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree
It takes a long period to recoup the financial investment (long payback period)	○	○	○	○	○
There is a low level of feed-in tariffs for the investment	○	○	○	○	○
Solar systems help to reduce pollution in the environment	○	○	○	○	○
Solar systems generate savings	○	○	○	○	○
Solar systems require the same amount of maintenance as grid-power source ("Eskom")	○	○	○	○	○
Solar systems are intrusive and affect the aesthetics of your home	○	○	○	○	○
Solar systems are value for money	○	○	○	○	○

Solar systems are an affordable technology	○	○	○	○	○
Solar provides a reliable source of power	○	○	○	○	○
Solar could develop in the future	○	○	○	○	○
Solar systems add value to a property	○	○	○	○	○
Solar systems reduce carbon emissions	○	○	○	○	○
Solar systems provide a visual statement of beliefs	○	○	○	○	○
Solar systems are easy to install	○	○	○	○	○
Solar systems are a safe form of power generation	○	○	○	○	○
Solar power is compatible with modern living	○	○	○	○	○

End of Block: PART 2: Using rooftop solar power in your home

Start of Block: Adoption Behaviour

Q14 Please rank the following potential motivators in order of importance for your decision to adopt a residential rooftop solar PV system, with 1 being the most important and 5 being the least important:

☐ ______ Environmental Concerns (e.g. reducing carbon footprint, supporting renewable energy)

☐ ______ Economic Benefits (e.g. savings on electricity bills, feed-in tariffs, payback period)

☐ ______ Technological Interest (e.g. enthusiasm for new technology, interest in solar energy)

☐ ______ Social Influence (e.g. neighbors or friends adopting solar PV, positive reviews and testimonials)

☐ ______ Power Reliability (e.g. mitigating the impact of frequent power outages)

Q15 Do you regard yourself as Pro-solar?

○ Actively

○ If asked

○ Neutral

○ Not at all

Q16 How well do you feel informed about the benefits and workings of solar PV systems?

- Not well at all
- Slightly well
- Moderately well
- Very well
- Extremely well

Q17 What do you perceive as the main barriers to adopting solar PV systems?

	Not a Barrier	Minor Barrier	Moderate Barrier	Major Barrier
High initial cost	○	○	○	○
Lack of information	○	○	○	○
Technical concerns	○	○	○	○
Regulatory or permitting issues	○	○	○	○

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11. Display This Question:

12. If Do you have a rooftop solar photovoltaic system installed in your home? = Yes

Q18 What is the capacity of your solar PV system (in kW)?

____

13. Display This Question:

14. If Do you have a rooftop solar photovoltaic system installed in your home? = Yes

Q19 Do you have battery storage installed with your solar PV system?

- ◯ No
- ◯ Yes

15. Display This Question:

16. If Do you have a rooftop solar photovoltaic system installed in your home? = Yes

Q20 How long have you had your solar PV system installed?

- ◯ Less than 1 year
- ◯ 1-3 years
- ◯ 3-5 years
- ◯ More than 5 years

17. Display This Question:

18. If Do you have a rooftop solar photovoltaic system installed in your home? = Yes

Q21 What was the approximate cost of your solar PV system?

- ◯ Less than 25,000
- ◯ 25,000 - 75,000
- ◯ 75,000 - 150,00
- ◯ 150,000 - 300,000
- ◯ More than 300,000

End of Block: Adoption Behaviour

End of Survey
We thank you for your time spent taking this survey.

Your response has been recorded.