Gordon Institute of Business Science
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FACTORS INFLUENCING THE ADOPTION OF PHOTOVOLTAIC TECHNOLOGY AS AN ALTERNATIVE ENERGY SUPPLY IN HOUSEHOLDS:

THE CASE OF PARKHURST, SOUTH AFRICA

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ABSTRACT

Compared to other parts of the world, solar energy products in South Africa (rooftop photovoltaic (PV) in particular) have very low levels of market penetration. This is despite South Africa been advanced economically and blessed with a favourable climate. This study sought to establish levels of acceptance and uptake of rooftop PV in Parkhurst, a small upper income suburb in Johannesburg, South Africa. To this end, a social media driven survey was undertaken with residents and in-depth interviews were conducted with key stakeholders including a solar PV company owner, the local councillor, various local community leaders, an energy expert, an estate agent and representatives of local finance houses. It was found that uptake of rooftop PV products in the suburb is low, despite their attractiveness in terms of being environmentally friendly, being able to assist the residents deal with local power blackouts (known locally as load shedding) and local power outages. There were multiple reasons for the poor uptake. Firstly, there is little to no support from the municipality, the dominant electricity supplier (Eskom) and the State for rooftop PV with no feed in tariffs; no subsidization of solar installations; an inactive demand side management campaign; no tax rebates and no pressure on the banks to provide finance. Secondly, consumers are somewhat fearful of roof top PV as they do not understand the technology and do not know if they can trust the suppliers thereof. Thirdly, rooftop PV are considered expensive, representing a significant capital outlay which will take years to provide a return on investment and may or may not contribute to the resale value of the residence. Fourthly, residents have multiple demands on their income, thus, the installation of a rooftop PV is usually a low priority. Fifthly, financial institutions in SA take a very conservative outlook to financing these products and extending credit. Interest rates are high and currently there are few, if any, bank-accredited PV suppliers. Lastly, the solar companies have not marketed themselves and their products well, focusing on selling the PV product, instead of bundling it with a maintenance service plan and a financial package. Going forward it is recommended that such companies focus on building their brand, building trust and building a relationship with the community. Looking ahead, rooftop PV has an opportunity to become accessible and mainstream in South Africa as formidable electricity tariff increases are on the horizon, which, in conjunction with maintenance and aging infrastructure issues that will mean more load shedding and outages, are likely to push many consumers to adopt demand side management strategies and alternative power sources such as solar.

KEYWORDS

South Africa
Off grid
Finance
Blackouts
Rooftop photovoltaic

DECLARATION

I declare that this research project is my own work. It is submitted in partial fulfilment of the requirements for the degree of Master of Business Administration at the Gordon Institute of Business Science, University of Pretoria. It has not been submitted previously for any degree or examination in any other University. I further declare that I have obtained the necessary authorisation and consent to perform this research.

13th January 2016

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1.1. Introduction to the research problem

1.1.1. The State of South African Energy

South Africa is facing an energy supply dilemma, firstly from an overall cost point of view and secondly, from a reliability of supply perspective. For the South African consumer, the cost of electricity has increased 169% over a ten-year period. Most of that increase has taken place in the last five years (Eskom, 2015). The price increases can be attributed to the fact that Eskom, South Africa's dominant and state-owned power utility, finds itself in a funding crisis. Eskom has insufficient money for the construction of new electricity generation plants, power station maintenance and its exploding operational costs. Its funding deficit is upwards of R230 billion and it seeks to satisfy this by means of an increase in tariffs, an increase in State guarantees, more long-term loans and/or the issuing of equity to raise share capital (David, 2015).

In addition to the funding deficit and, consequently, rising electricity tariffs, Eskom is also grappling with a significant maintenance backlog (Sikonathi & Charlotte 2015). Hence, since 2008, the country has experienced regular blackouts, known locally as load shedding. Thus, consumers are dealing with the negative effects of rising electricity costs and an intermittent and unreliable supply of electricity. People do support economic reform in the shape of tariff increases if it is in their direct self-interest, however increases in an era of poor supply significantly minimises such benefits (Aklin, Bayer, Harish, & Urpelainen, 2014). This is because periods of no electricity mean that daily business operations and household functions are negatively affected. The lack of reliable, constant and cost-effective energy is hampering economic growth and so, unsurprisingly, South Africa's GDP growth was only 1.3% for the first quarter of 2015 (StatsSA, 2015b). Thus, businesses and households alike are taking steps to both reduce their electricity consumption - namely to lower their utility bills and reduce their dependence on the electricity grid - to ensure continuity of supply. Overall, the combination of higher tariffs and load shedding has seen 41% of South Africa's population reduce their consumption of electricity (DoE, 2012).

1.1.2. South African demographic impact on the energy market

During the same period, South Africa's population has grown by 16% between 2001 and 2011; at this rate the population will double in 62.5 years (Turok & Borel-Saladin,

2014). The vast majority of this population will need access to electricity to improve their standard of living as electricity plays an essential role in improving an individual's quality of life and economic growth (Chaurey, Krithika, Palit, Rakesh, & Sovacool, 2012). Very few, however, will be able to pay the high tariffs and so will need to have, at the very least, a 'lifeline electricity supply' that is essentially free of charge. This means that municipalities have to cross-subsidize, using funds obtained from wealthier consumers. Consequently, municipalities need these middle and upper class consumers to remain connected to the grid and keep their utility account in good standing. Although disposable household incomes of the middle class (both black and white) in South Africa have increased, these people are now investing in energy-saving technologies, reducing their electricity consumption and exploring ways to go off grid (Radebe, 2013). Load shedding is also reducing consumption, and therefore electricity bills. Consequently, the financial contributions of middle and upper class households to the municipality are diminishing over time and the amount of money available for cross-subsidization is under threat.

1.1.3. Technology development and a window of opportunity

The ailing supply and management of energy in South Africa has opened up a window of opportunity for consumers to source alternatives. In this process, they not only educate themselves on new technology, but they also start understanding the environmental and economic benefits of that alternative supply such as solar energy. Among the renewable energy sources, solar energy is one of the most abundant and largest potential energy sources in the world; however, efficiencies of the technology and the cost can make a system economically unviable. In most studies done on the efficiencies of solar, which is measured in We/m2 and also known as power density, the authors project that the improvement will be significant over the next few years and double in its capacity to generate power (Sahu, 2015). This improvement in efficiencies varies across materials with dye-sensitized and organic-based cells being the lowest at 5.4% efficiency levels, thin film solar cells at 19.9% and mono/polycrystalline cells at 24% efficiency (Sahu, 2015). As these efficiencies improve, costs continue to decline at 20% - 30% annually.

1.1.4. Policy driving energy generation behaviour

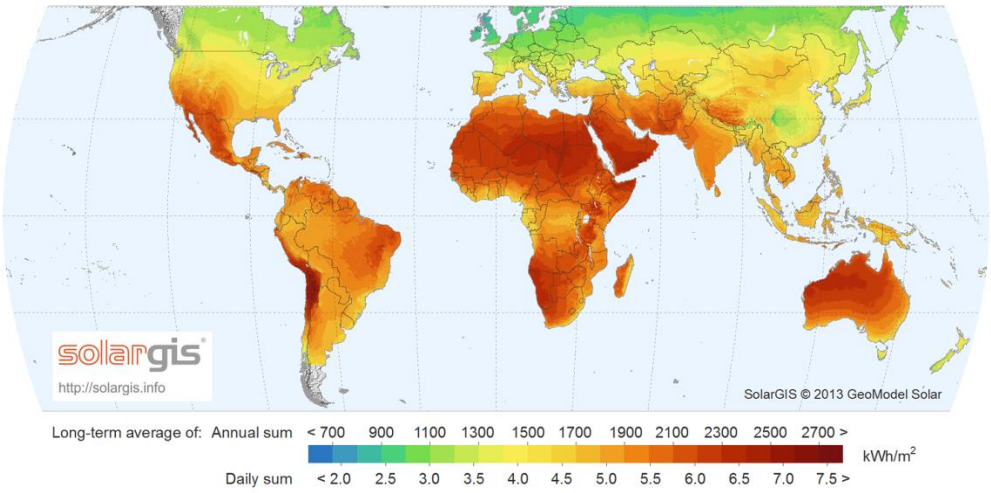
Another influencer is the presence, or lack thereof, of policy around renewable energy.

Globally there are financial policies that allow for tax breaks on the capital expenditure in order to encourage consumers to invest in solar technology. There are also policies such as the “feed in tariff” (FIT) policy that encourage consumers and investors to adopt solar and generate a payback by selling back into the utility grid. In countries that allow this, a grid-tied system is the most popular format; this grid-tied system includes panels, inverters and all other components; however, the system does not include battery storage.

This ability does not come without its challenges as governments and national utility companies need to ensure that there is a balance between energy supplied by them and energy generated independently by the consumer. Currently, South Africa does not have any formal policies highlighting the future of renewable energy generation and does not permit any feed into the utility grid.

There is a growing trend amongst countries that have a developed Photovoltaic (PV) market where they are now dealing with the implementation of PV being too successful and have since started throttling their policy-related incentives, which not only unsettles the market for manufacturers and suppliers but it puts doubt into the consumer’s mind. Japan is one of the top ten PV-generating countries globally and has a similar monopoly of supply to South Africa. Due to conflicting interest between renewables energy and fossils energy, Japan has not seen growth in its renewable energy generation in ten years from 2000 – 2010, which is a worrying statistic. Issues cited about the country’s FIT structure is that the monopolistic utility companies are not obliged to give any priority access to renewable energy suppliers; they are also not obliged to expand the grid to accommodate renewable companies and lastly the large energy companies own transmission, distribution and retail business, making it difficult for renewable suppliers to influence the market.

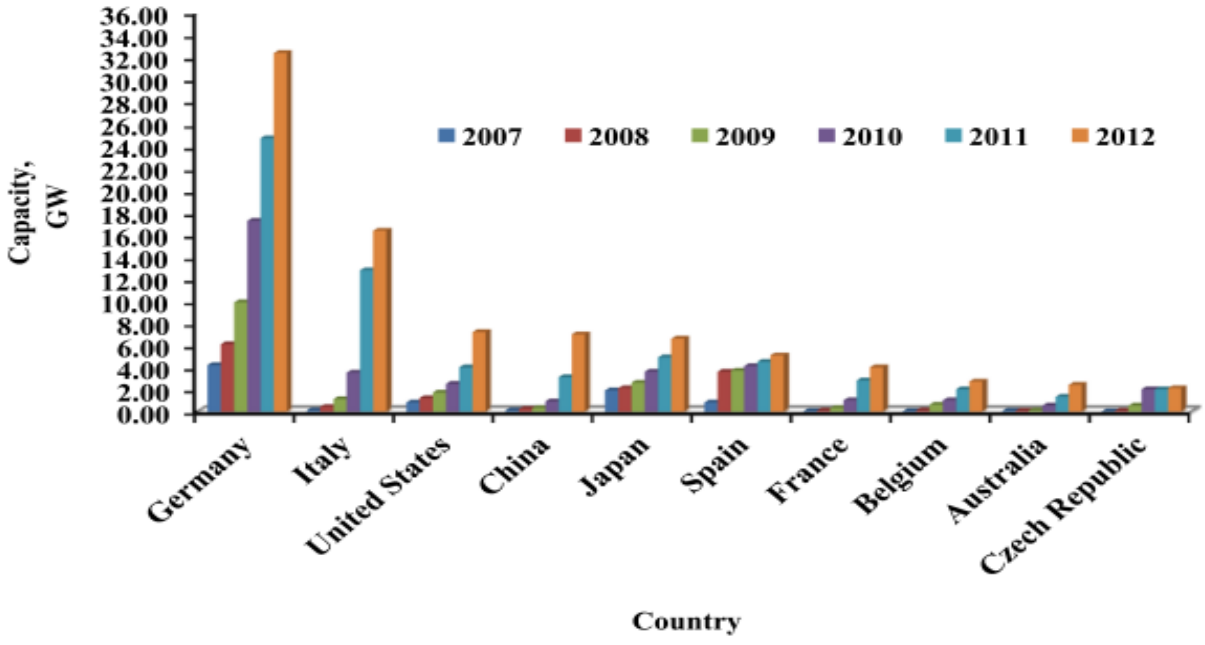
Figure 1.1: Solar irradiation map of the globe



(Solargis, 2015)

From the Solargis map above, one can see that South Africa, along with Australia and South America, has some of the highest levels of solar irradiation - measured by the amount of Kilowatt hours per square meter, KWh/m2, hitting the earth. However, South Africa is not one of the top ten countries generating power from PV, as can be seen below.

Figure 1.2: Solar capacity by country by year



(Sahu, 2015)

Prior to 2007 /2008, South Africa was recognised as a country with reliable and affordable electricity. However, since then it is now seen as a country progressively less able to keep the lights on and with massively increasing costs (Parsons, Krugell, & Keeton, 2015). Since 2008, electricity tariff increases have significantly exceeded the inflation rate. Rising utility costs, coupled with load shedding, are becoming a powerful incentive for customers to reduce dependence on the national grid (Eskom), some of whom may elect to do this by permanently going off-grid (Parsons et al., 2015). The availability of renewable energy sources, such as solar geysers, is helping customers make this shift.

1.1.5. Immediate short term steps

Reducing electricity costs and ensuring reliability of electricity supply is becoming a significant priority for many South African households. With seemingly little end in sight for Eskom's financial and infrastructural woes, South African households now face an uncertain electricity outlook (Ginindza, 2015). Part of the solution - and one even advocated by Eskom itself - is to reduce dependency on the grid by installing solar geysers. As geysers account for up to 40% of a household's total electricity bill, the adoption of a solar geyser should lower a customer's utility bill, and reduce electricity demand. For customers, solar geysers offer the attraction of having hot water even during load shedding cycles and reducing their electricity bills. The emphasis on solar geysers also forms part of the State's strategy to promote alternative sources of energy, which include hydro, gas solar, nuclear, centralised solar plants (CSP) and wind (DOE, 2013). In a survey done by the Department of Energy, in 2012, 26% of the respondents claimed they had made use of other energy sources to cope with the increasing electricity prices (DoE, 2012). Of all the renewable energy types, however, solar is by far the most accessible to households (DOE, 2013). Other behavioural changes adopted by households include:

(i) switching off lights when leaving the house (75%);
(ii) using energy saving lighting (67%); and
(iii) switching off appliances at the wall when not in use (59%).

Although these behaviours will reduce energy demand, they are insufficient to stall the growing concern about supply (DoE, 2012).

1.2. Motivation and approach for research

Given the above parity between opportunity and the level of solar being exploited in South Africa, the aim of this research project was to explore what steps households of a middle class/upper income suburb, located in Johannesburg, have taken to reduce their utility bills and their reliance on the electricity grid. The selected suburb, Parkhurst, covers an area of 1.64km^2 and consists of 2379 households. There are 4 851 formal residents of whom 3 093 are employed, 450 unemployed and the balance are not eligible for employment. The average household income is between R400 – R600k per annum (StatsSA, 2011). Parkhurst is representative of the middle to upper income demographic that this research focused on and is home to residents who have been exposed to community technology projects so they should be more au fait, and possibly more willing, to adopt new technology than other residents and communities. Parkhurst is not only known for its trendy appeal it also has a very active village-type atmosphere and a diverse, yet integrated, community. This suburb took the initiative to start its own community policing initiative, it was also the first community-driven suburb to roll out fibre-to-home technology successfully, and it is now focusing on a green approach to living with its Go Green initiative.

The research centred on the exit, voice and loyalty framework by Albert Hirschman as well as diffusion of innovation by Everett Rodgers and it was important to understand the impact that a community has on the adoption of technology. This was a contributing factor as to why the research questionnaire was focused on the Parkhurst community.

The research consisted of an exploration of household energy-efficient practices, household utility accounts and the household adoption of renewable energy technologies. In order to do this, an online questionnaire was developed and aimed at a representative population with a required minimum response of one decision-maker in 20 households. In order to ensure the quality and number of responses, respondents were given between two and six weeks to respond to the web-based questionnaire. In addition, in-depth interviews were conducted with the local government representative, an energy industry expert and solar entrepreneurs operating in and around the area. A month was allocated to conduct the in-depth interviews with relevant parties (Saunders, Lewis, & Thornhill, 2012).

This study aimed to gain better insight as to whether (and how) middle to upper income

households in Parkhurst are managing their electricity consumption, given the conundrum of cost and supply in South Africa. In addition, the study sought to establish what the barriers and facilitators to the adoption of demand-side management behaviours and technologies are, and what they are with respect to the adoption of alternative energy sources. There was particular emphasis on PV in the light of Eskom solar geyser initiative and the DoE (2013) report. As such, the research explored household energy usage and sustainability from a financial, economic and social point of view; it sought to understand the impact of community activity on the adoption of EE measures/technology and PV; as well as to identify what the main barriers to EE measures/technology and PV adoption are.

2. LITERATURE REVIEW

2.1. Introduction

In order to properly understand the topic and identify the factors that drive companies' and consumers' decisions to adopt solar technology, three main themes were identified.

The first theme aimed at understanding the degree of motivation to achieve independence from the State or municipality in terms of service delivery. The second theme focused on the solar technology itself and how consumers perceive it. The quality of the technology was only one of four elements that influenced the adoption thereof; influences such as management and social acceptance also played a key role, as seen in the IASAM model. This led to understanding the last theme of sustainability - expansion of the literature highlights that sustainability is an ever-growing topic and influence, which, as time goes by, is reliant on its environmental, economic and the lesser understood social pillar to build credibility.

The review of literature not only allowed the researcher to identify the various themes discussed above, but also to identify sub themes which compelled further research. This research was necessary to understand not only the superficial level of solar energy adoption, but it was also necessary to explore the impact of social acceptance of technology on adoption and the deeper impact on a country's population and economy, given the lack of basic human needs such as energy.

The review of literature also assisted in the design and execution of in-depth interviews with industry specialists and an audience with considerable knowledge to add to this field.

2.2. Exit, Voice & Loyalty

The concept of exit, voice and loyalty was used as a theoretical framework in this research, due to its relevancy around issues pertaining to public service delivery, of which electricity supply is one. The effectiveness of the delivery of public services can be measured by its ability to satisfy citizens' needs, wants and expectations. However,

satisfaction levels often reflect the quality of life perceptions and the degree to which they trust their government (Gofen, 2012). Measuring the extent to which the service provided by the state is satisfactory or not is therefore challenging, because notions of satisfaction are fluid. In this void, the work of Albert Hirschman (1970) can be used to determine if a subgroup of a population is indeed satisfied with service delivery or not. Hirschman (1970) claims there are three main types of responses to States, firms or organizations when its followers experience unsatisfactory service delivery. One of these responses is “exit” which is leaving without trying to remedy the situation. Gofen (2012) notes that exit can also be seen as replacing one service provider with another. This, obviously, presupposes service delivery alternatives.

A second response is “voice”, an approach that sees the follower/s speak up and try to remedy the situation, however the successful outcome depends on the action of the service provider (Hirschman, 1970); that is, how well the service provider responds to the complaints and demands of the customers. This is often affected by the existence of (or lack of) alternatives. If the service provider is aware that the customer has no alternatives, the service provider is a monopoly - there is little incentive to respond positively to “voice”. Lastly, there is “loyalty”, which is viewed as a passive response, whereby the customer is unhappy but does nothing (neither exists, nor expresses their views) and remains in the system. Both voice and exit are active responses to dissatisfaction with the purpose of improving the level of service by expressing issues and concerns either individually or as a community (Gofen, 2012).

Citizen participation, which in Hirschman (1970) framework is a form of voice, has been known to fluctuate with the level of quality of life - that is citizens who have a high quality of life tend to be more engaged in the democratic process. Thus, Yonk and Reilly (2012), found in the United States of America that direct democracy as a form of active citizen participation. Direct democracy can involve citizen initiatives, referenda and recall elections. It provides its citizens the opportunity to contribute to policy outcomes and they are seen to have more influence over policy-making, specifically those that directly affect them.

Yonk and Reilly (2012), have found that access to sufficient and affordable electricity influences a citizen’s quality of life, which will influence their level of democratic involvement. This quality of life measure is made up of eight indices that look to build a holistic view on the quality of life a citizen enjoys. Purchasing power is one of the

quality of life indexes and is influenced by the level of accessibility to basic electricity. These indices can be seen as a measure in Numbeo's quality of life index (Numbeo, 2015). If quality of life increases the democratic participation of citizens, then the opposite is also true, as the quality of life decreases so society contributes less in terms of votes, initiatives and active participation and starts to look at the option of Exit as an acceptable alternative (Yonk & Reilly, 2012).

As mentioned earlier, South Africa is not only dealing with increases in electricity pricing linked to purchasing power, but poor supply as well.

2.2.1. Benefits and Impact of Exit

Hirschman (1970) argues that in a situation of reduced levels of satisfaction and/or in the absence of trust, customers will opt for exit over voice. This is because exit is a quicker, easier and less emotionally draining option. However, the act of exiting is an individual-orientated option. It is inherently selfish, as it is usually one in which the individual who is existing 'wins' but the community from which he/she disassociates, "loses".

This is true and evident in the case of a study done on civil nuclear cooperation. It is presumed by most that cooperation develops a bilateral relationship between two countries however, Hymans (2011) argues that the relationship engenders reverse technology transfer and negatively affects the developing country due to scientific workers being exposed to broader horizons and migrating from their environment to a better one. This is also known as the "brain drain", leaving the developing country without the capability to implement their nuclear ambitions and ultimately seeing the degradation of their programs (Hymans, 2011).

In the case of State-supplied electricity, therefore, where wealthy households cross-subsidize the poor, exit by wealthy households will have a negative effect on greater society as there is less money for cross-subsidization. Hirschman (1970) claims, therefore, that those who depart from the communities do so with little or no thought of trying to stay and improve the situation, or even setting up competition and improving the situation "from the outside"

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Hirschman (1970) notes that there is a relationship between the act of exit and upward

social mobility, that is as individuals improve their lot in life, rise up the social ladder, or gain socio-economic status, they tend to exit the lower-ranked group that they once belonged to in order to join a higher-ranked group. Thus, individual success seldom benefits the lower-ranked group as a whole.

However, a form of exit whereby citizens act proactively by producing, initiating or delivering alternatives, known as Entrepreneurial Exit, can have significant positive benefits (Gofen, 2012). Buchanan and Tullock (1962) posit that exit within free market economics – namely, an economy in which customers are not trapped into narrow, limited options, the threat of exit or exit itself can ensure deal-making to the benefit of all. Witt (2011) and Bejou (2012) concur with this theory.

2.2.2. Application & impact of Voice and Loyalty

The second element of Hirschman's theoretical construct is that of voice. It has been found that studies have not been as extensive and thorough due to the lack of clarity in Hirschman's framework of voice compared to that of exit. This is in part due to the fact that there are varying levels of voice which are not as dichotomous as the options for exit - which is exit or not (Salucci & Bickers, 2011).

Voice can be used individually or collectively through either individual complaints or collective action or collective voting. While individual voice may serve to appease the aggrieved individual, collective voice is the only one that brings about broader policy change (Salucci & Bickers, 2011). Voice is the articulation of discontent with a product, service or policy (Witt, 2011). Practically, voice normally takes the form of voting, complaints, petitions or protests. An extreme form of voice is revolt (Fleck & Hanssen, 2013). Revolt can be passive or peaceful, which could include refusal to pay, sit-ins or mass marches/mass demonstrations. Revolts of this kind are common in poorly-governed states. In such countries, the option of exit (emigration) is unattainable for most people, leaving many with voice as the only active option. Sadly, passive or peaceful voice options do not render the desired results and so only the threat of revolution or actual revolution (active, violent) leads to an improved quality of government (Fleck & Hanssen, 2013).

Thus, the power of voice is derived from a type of exit. That is, voice can only have a real effect if the threat of exit (exile of the politicians involved, a revoking of their right to

rule) is real. Unfortunately, the application of voice, although born from a place of loyalty and willingness to improve, has a history of being the less-used option, even though there is evidence that it has influence.

A core attribute of community satisfaction is the ability for citizens to express themselves, but key to making it effective is the speed and level of responsiveness by officials responsible for the issue (Salucci & Bickers, 2011).

The researcher also noted that within the polar nature in which voice and exit are described is loyalty, the third element, which has attracted the least amount of attention in the literature, and is seen as a passive approach while voice, and most certainly exit, are seen as active (Gerken, 2013).

At first glance, loyalty may be seen as protection against the easy choice of exit, and is not seen as an avenue of influence but rather as a cushion against the easier, preferred hasty exit in a situation of dissatisfaction (Hirschman, 1970). However, upon more careful assessment of the literature, loyalty can be seen as another avenue of influence and not only protecting the organisation against exit but giving loyal members a more dominant share of voice that the organisation listens to and learns from (Gerken, 2013). By improving their understanding of citizen's needs, firms or organisations may see an improvement to adoption of imperatives and even technology.

2.3. Impetus to Adoption

2.3.1. Diffusion and Development of Technology

With the increasing level of competition in markets today, the need for innovation has become a necessity. This has naturally brought on a need to understand the success of these innovations and through analysis, researchers can understand the impact and effectiveness of the innovation (Kapoor, Dwivedi, & Williams, 2014).

There are many models that have been developed, with most of the focus coming from psychology and sociology theory such as, Theory of Reasoned Action (TRA), Theory of Planned Behaviour (TPB), Technology Acceptance Model (TAM), Decomposed Theory of Planned Behaviour (TPB) and Diffusion of Innovation (DOI) (Kapoor et al., 2014). The Theory of Diffusion of Innovation (DOI) can be used to understand how consumers

migrate to and adopt new technology, such as alternative energy. According to Rogers, there are five attributes that are seen to be attributes of innovation, namely relative advantage, compatibility, complexity, trialability and observability (Kapoor et al., 2014). The aim of this study was to see the influence of these attributes on the adoption of solar technology as an innovation.

The Theory of Diffusion of Innovation was developed by Everett Rodgers in 1962. He uses the terms innovation and technology synonymously, and defines it as an idea, practice or object that is perceived by individuals as new (Aizstrauta, Ginters, & Eroles, 2015; Rogers, 1962). For the purpose of uniformity within this literature review, the work technology will be used. The Diffusion of Innovation Theory (DOI) is a well-established theory and most commonly used and despite authors having studied alternatives, it has been found that many of these alternatives are rooted in Rogers's DOI theory (Kapoor et al., 2014).

While assessing the various literature, there was very little that distinguished the different theoretical frameworks, however two studies that were noteworthy were a Meta-Analysis study done by Tornatsky and Klein in 1982 and Perceived Characteristics of Innovating Theory by Moore and Benbasat in 1991. Their distinction was that they identified 33 and five attributes respectively, which affected the intention and adoption of innovation. All of these were then whittled down to a further additional nine, of which all were pertinent to this study. These attributes are cost, risk, ease of use, image, visibility, voluntariness, result demonstrability, social approval and communicability (Kapoor et al., 2014).

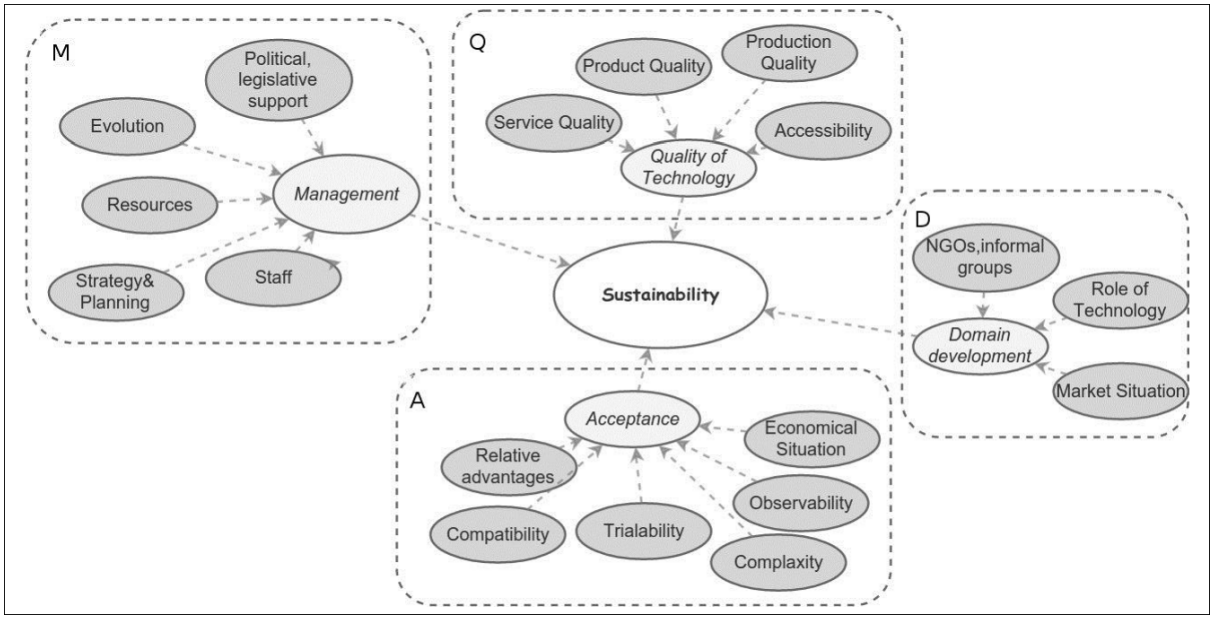
Rogers (1962) also suggests that an individual or decision-making unit (DMU) moves through various stages in the technology adoption process:
Stage 1 - Knowledge;
Stage 2 - Forming an attitude;
Stage 3 – Decision to adopt or reject;
Stage 4 – Implementation: and then
Stage 5 – Decision confirmation

Mirroring the extended DOI work done by Moore and Benbasat in 1991 in which they highlighted social acceptance as one of the additional nine attributes, Nygrén, Kontio, Lyytimäki, Varho, & Tapio (2015) claim that technology diffusion is also a social

process and in the case of large-scale sustainability, transitions require attention to not only technologies, but also to cultural meaning, policies, information sharing and markets. Thus, there is a model that looks at diffusion from multiple dimensions. This is known as the Integrated Acceptance and Sustainability Assessment Model (IASAM) which integrates acceptance evaluation with socio-technical factors (Aizstrauta et al., 2015). The model is useful as it can assess technology adoption from a sustainability and acceptance point of view at any given point in the lifecycle of a specific technology (Aizstrauta et al., 2015). The presence of multiple dimensions in innovation acceptance is also supported by Rogers (1962), in that not all innovation is the same and despite the steps of diffusion some succeed and some fail (Aizstrauta et al., 2015).

Acceptance and sustainability is tested through the IASAM model seen in the diagram below, (Fig. 1). The model highlights four main influencers, namely Quality of Technology, Domain Development, Management and Acceptance (Aizstrauta et al., 2015).

Figure 2.1: Integrated Acceptance and Sustainability Assessment Model (IASAM)



(Aizstrauta et al., 2015), p. 71)

Focusing on the quality of technology that influences adoption, the characteristics of the technology affect the likelihood and speed of the adoption, with relative advantage one such characteristic. The relative advantage refers to the degree to which the technology is perceived to be superior to the one it supersedes, considering both economic and non-economic factors (Vasseur & Kemp, 2015). And with South Africa's

case in mind, the research aimed to understand how interrupted supply degrades the perceived quality of power supplied by the current utility.

In a study by Labay and Kinnear (1981), it was found that the inclusion of knowledgeable, non-adopters added value, due to their product and economic factor assessment, assessing factors they ranked fairly highly in the decision not to adopt (Vasseur & Kemp, 2015). In a similar adoption study, it was found that through small wins, experimentation and fumbling along, solar energy is diffused far more effectively and with more success in the long-run than if it was diffused through conventional wisdom or large-scale research and development. However it is still noted that the environmental factors of solar are viewed as favourable, but it is the financial, economic and aesthetics that limit the adoption (Vasseur & Kemp, 2015). Contrary to this fact Vasseur and Kemp (2015), a study done by Palm and Tengvard showed that contribution to a better natural environment was rated as the most important motive for adoption, although Vasseur and Kemp (2015) do not agree.

Factors other than the quality of technology in the IASAM model also contribute to the adoption of technology and, specifically in the case of global renewable energy, are elements such as limited resources and by association, increasing prices. These management elements, or lack thereof, elevate the importance of government and policy, which then act as influencers to innovation-driven change, which in turn further emphasises the social impact (Nygrén et al., 2015).

The challenges present themselves when the heightened importance of state and policy are present but fail to deliver, and Hirschman's exit voice and loyalty construct identifies these failures as accelerators to alternative adoption.

2.3.2. Communities and their impact on adoption

Taking cognisance of the social element in technology adoption it was noted in the literature that even when cost-effective motives are present, the lack of supporting social structures makes it difficult for adoption - people are hesitant with technology adoption as it takes too much effort at a personal level and they would rather wait until levels of experience have been built up and established practices put in place to minimise the risk of unexpected issues (Nygrén et al., 2015). This may be a contributor to the low adoption rates on PV, which need to be better understood.

Further support for the impact of communities on the adoption of technology specifically, is housed in the literature of early adopters, however this is in the form of collective, self-built user-communities, supported by social media, to enable the sharing of information, experiences and expertise. Evidence shows that these communities significantly stimulate diffusion of technology (Nygrén et al., 2015).

2.3.2.1. Caution when assessing social impact on adoption

Given the discussed need for social structures as an influence to adoption and Nygrén et al. (2015) view of adopter communities built through social media, there is still a contradictory view which has shown that social influence has a positive and diminishing effects when looking at social influence over time. As more information and common knowledge is gained or built, so the need for socially-obtained information is diminished (Risselada, Verhoef, & Bijmolt, 2014). This research aimed to understand the level of influence communities have on the South African adopter and the potential adopter of solar technology.

Risselada et al. (2014) distinguish between recent adoption and cumulative adoption whereby recent adopters are the people that have adopted lately and cumulative adoption highlights a trend over time in a personal network, with the effects varying between the two. It has also been found that the contagion effect, which is the level of exuberance of interest, remains constant from the product introduction stage and does not diminish from that stage onwards, which means adopters remain enthusiastic and share their opinion immediately after their adoption (Risselada et al., 2014). It has also been reported that early adopters are more contagious than later adopters as they score higher on the need for involvement and opinion leadership requirements, with the consequence being that they exert a stronger influence on the late adopters (Risselada et al., 2014).

Certain diffusion literature has a divergent view and claims that the impact of social influence diminishes over time due to familiarity of technology and knowledge about the technology by a broader group or community, with that technology becoming the norm (Risselada et al., 2014). This norming process is also a description of cumulative adoption, as highlighted above; the authors find that each additional adopter has influence and the influence does not diminish over time (Risselada et al., 2014).

2.4. Sustainability

Within the context of massive environmental destruction on a global scale, the adoption of technology is also linked to issues of sustainability (EPA, 2015). The adoption of energy efficiency measures, technologies and renewable energies, for example, is often done within the context of the need to reduce greenhouse gas emissions and combat the effects of climate change (Edenhofer et al., 2011). Thus, addressing problems from the perspective of sustainability has become a strong focus for broader society, government and business. The environmental improvement needs identified by Edenhofer et al. (2011) have evolved from being " nice-to-haves" in businesses, to being recorded on various global reports as "must-haves". A study of CEOs on the topic of sustainability showed that 93% of them viewed sustainability as a critical issue for the future of their businesses (Larossi, Miller, O'Connor, & Keil, 2013). While 96% of these CEO's claimed that sustainability should be fully integrated into their strategy and operations, it was the challenge of execution that slowed down the said integration (Larossi et al., 2013). This research aimed at establishing if this same top down approach to renewable energy execution is a key driver of household adoption through business and government initiatives.

In a separate study Winkler (2005) stresses a similar disjoint between expectation and delivery of sustainable energy. He highlights that solar energy is by nature renewable and on a time-scale of human relevance, will not be exhausted, unlike the limited supply of fossil fuels. However, the theoretical benefit of solar energy is far greater than the applicable benefit, due to diffuseness and intermittency. This means that the technological, market and economic elements pose challenges between theoretical and practical potential (Winkler, 2005).

Some of these practical challenges can be explained by technical lock-in, which is influenced by decisions made in the past or design phase (Zerjav, 2015). History shapes current decisions while path dependence in terms of infrastructure plays a resistant role in the development and adoption of renewable energy initiatives (Barnett et al., 2015).

Man-made material structures in geographic locations, such as power stations or an electricity grid, are extremely relevant when deciding on energy policies - environmentally friendly or any other kind (Scholvin, 2014). The pre-dominance of coal-

fired power stations dictates a series of events when it comes to South Africa's energy policy decisions. Although these decisions were made 30 – 40 years ago, they still affect decisions made today and shutting down coal powered stations would mean financial loss (Scholvin, 2014).

In light of these points, the execution of sustainable initiatives is highlighted as a challenge and it is not in isolation. Further literature purports that measuring the successes of sustainability initiatives compounds the challenge and as sustainability is becoming more of a focal point, it is still difficult to measure due to the challenge of selecting the correct sustainability indicators (Liu, Baniyounes, Rasul, Amanullah, & Khan, 2013). The three main challenges set out by Liu et al. (2013) in developing sustainability indicators are selection, quantification and aggregation (Liu et al., 2013). These indicators may also play a vital role in adoption by educating policy-makers and consumers on the benefits of solar energy.

2.4.1. Social Sustainability

While pundits such as the CEs mentioned earlier continue to promote sustainability dialogue and action, more often than not it is focused on the environmental and economic elements of sustainability. The third element, namely social sustainability, received the least amount of attention in the tripartite corporate reporting (McKenzie, 2004). McKenzie (2004) defines social sustainability as "a life-enhancing condition within communities, and a process within communities that can achieve that condition". Social sustainability is the least expressed and understood element of sustainability. However for societies to move towards a more sustainable environment, we are reliant not only on our knowledge of ecosystems and resources, but on our ability to initiate, advocate and absorb lifestyles, values and technology (McKenzie, 2004). McKenzie (2004) identifies a few important aspects of this process, including the importance for individuals to enjoy equitable access to key services such as energy housing, education, transport and healthcare. There also needs to be a system to transmit awareness of social responsibilities from one generation to the next, and with a technology that has so much to offer, it is important for this research to understand what drives society to adopt solar technology.

Increasing awareness of the true costs of human economic activity on the planet means that people are becoming attuned to the notions of "reducing ecological

footprints" and "living sustainably". As such, these values are playing a key role in decision-making processes when it comes to product, brand or technology selection (Chen, 2014). In support of this growing trend it is noted that industry leaders have started making structural changes to their executive teams in line with sustainability goals. Companies such as Coca-Cola, United Parcel Services and Alcoa have even added a Chief Sustainability Officer to their boards (Crosno & Cui, 2014). However there are still barriers such as incompatibility with existing practices, perceived inferiority and heighted perceived risk within society that slow down the adoption of renewable energy technology as an example (Crosno & Cui, 2014). Also noted by Crosno and Cui (2014), a supplier value chain has a large part to play in the breaking down of certain barriers, giving consumers piece of mind about an often misunderstood technology. Consumer knowledge as an influencing factor to adoption is one element that was investigated in this research.

2.5. Conclusion

Our environment is under threat from the relentless growth and global development, which is being fuelled, figuratively and literally, through the sourcing and need for fossil fuels and oil. What is also evident is that the environment is not the motivating pillar for sustainability - it is further complicated by the economic viability and social sustainability as well. However the literature studied in the social sphere is limited. Society is also inundated by technological developments and the comprehension of these technology developments may be hindered by the level of knowledge required to understand them fully. This research aimed to understand what impact consumer knowledge has on the adoption of solar technology. The review of literature also brought to the fore the impact of consumer choice and expectations that these consumers have on government and what the outcomes would be if these requirements are not met. Within the construct of exit, voice and loyalty, it is necessary to understand where South African households are in terms of foregoing the "as is" scenario of coal-powered energy supply for a cleaner, more sustainable solar technology.

3. RESEARCH QUESTIONS

3.1. Purpose of research

In reviewing the literature on sustainability, technology diffusion and voice/exit, this research aimed to understand the level of influence these elements have on household energy consumption behaviour. The review led to the following research questions:

3.2. Research Questions

3.2.1. Research Question 1

What impacts do national factors such as government and institutions have on the adoption of solar technology?

3.2.2. Research Question 2

To what extent does the community/society, in which people reside, affect the adoption of solar cell technologies and/or energy efficient technologies/strategies?

3.2.3. Research Question 3

How do individuals' personal beliefs and aspirations influence the adoption of solar technology?

3.2.4. Research Question 4

What are the personal circumstances that motivate or discourage the adoption of renewable energy technology, such as solar?

3.2.5. Research Question 5

To what extent are middle class/upper income households electing to remain "on-grid"?

4. RESEARCH METHODOLOGY

4.1. Introduction

A review of the available literature highlighted the need to better understand factors that are influencing the adoption of solar technology in the household. The majority of the literature positions solar energy in a positive light for the future, however the level of adoption in a country like South Africa, is still exceptionally low. Added to this fact, South Africa is ranked as one of the highest possible-potential markets for solar technology in the world. It is for this indistinct reason that further in-depth research be done on the subject.

4.2. Research Design

4.2.1. Exploratory Study

From the Diffusion of Innovation Theory there are five elements that influence the rate of adoption, namely relative advantage, compatibility, complexity, trialability and observability (Nygrén et al., 2015).

This framework makes up an element in the process of understanding the adoption rate; but given the literature review it is clear to see that there is not only one theoretical construct that can explain the slow rate at which households make use of alternative sources of energy - it can be led by lack of delivery, the need for social inclusion or purely economics.

The research design that was selected to answer the research questions is supported by Saunders et al. (2012) whereby they identify three key research methods: Exploratory, Descriptive and Explanatory studies. Due to the nature of the research questions and the uncertainty of the precise causes of the issue and the descriptors above, the method that was chosen for this study was exploratory.

This selected approach was advantageous and complemented the research problem due to its flexible and adaptable response to change (Saunders et al., 2012). Open-ended questions were put to the respondents with very little need for structure, which encouraged the respondents to share their experiences, attitudes and perceptions

(Creswell, 2013). While the respondents often digressed from the topic slightly, the enlightened discussions were encouraged as much insight was gained during these divergent discussions.

4.2.2. Qualitative Approach

Based on the above categorisation, a quantitative and qualitative exploratory approach (mixed methods) was identified as appropriate. This approach was taken to understand purchasing decisions and household behaviour. The approach can be described as an interpretive philosophy; the research aimed to make sense of the subjective views and responses that were gained from respondents. (Saunders et al., 2012). The behaviour shown and feedback received was tested against the theoretical frameworks in an inductive manner whereby inferences for this specific South African market were made.

From the research within the qualitative literature it can be said that it is near impossible to properly understand why somebody does something or why something occurred without actually talking to the stakeholders, and to understand their motivations in an in-depth way. It is necessary for a researcher to actually engage in discussion (Myers, 2013). While engaging with industry specialists and conducting the qualitative in-depth interviews, the researcher found that while very topical, very few respondents were able to give qualified input as to where they believe the current power situation is heading in the near future. It must also be said that even as specialists, the respondents are also homeowners and feel the impact on a personal level. This is reflected in their feedback from time to time.

The in-depth interviews were conducted over a period of three weeks with respondents who have personal and professional experience in the renewable energy sector, as well as respondents who represent households and household communities. The interviews were conducted at a venue of their choice, with the majority choosing their respective residences and offices. The interviews were unstructured, which allowed the respondents to discuss their views and opinions freely, with only the occasional probing question on points of particular interest to the research study. The interviews were typically 45 – 60 minutes long.

4.2.3. Quantitative approach

The mixed-method approach to this research was chosen to understand the perceptions about solar adoption from households and residents. Quantitative research aims to classify, count and statistically assess results to try to explain what has been observed (McCusker & Gunaydin, 2015). Quantitative methods as part of a mixed-methods approach to research acts as a supporting role to qualitative research. Qualitative research is often used as a lead-in prior to conducting primary research through qualitative methods, such as interviews (McCusker & Gunaydin, 2015). In the case of this research, the qualitative research was used to understand in detail the energy situation and level of solar adoption in South Africa from experts, while the quantitative research aimed to understand the position and perception of households to further enrich the qualitative feedback.

Various statistical approaches were used to interpret the responses, some of which included T-hypothesis tests as well as determination of mean values for interpretive uses.

4.2.4. Questioning approach

According to Saunders et al. (2012), when adopting an exploratory study approach, both semi-structured and in-depth interviews can be used. The researcher chose in-depth interviews due to the nature of the personal contact required, the complexity and open-endedness of the questions as well as the time it was projected to take in order for the researcher to acquire the necessary information. It was found that amongst the respondents, different terms had different meanings and so the interviews were conducted in such a manner that theoretical terminology and jargon were avoided.

Qualitative research by nature is multi-faceted in its findings, which is due to researchers approaching the research uniquely and interpreting their observations uniquely (Merriam, 2014). Thus, to enhance the trustworthiness of the study, it became essential for the researcher to allow respondents to speak freely and in their own words

A critical incident technique (CIT) was used to ensure the most valuable information was extracted from the participants. The CIT approach to questioning makes use of participants' experiences rather than having conceptual discussions. Furthermore, the

application of CIT theory recorded positive and negative experiences from the respondents perspectives and themes were developed from the feedback (Hardin, Ruihley, & Veraldo, 2013).

Complimentary to these options was a questionnaire that was randomly distributed through social media pages such as Facebook and Twitter. The aim was to assist the researcher in gathering information about consumers' attitudes towards the research topic. The researcher was then able to further explore these attitudes through in-depth interviews (Saunders et al., 2012).

Because the research centres on the exit, voice and loyalty framework as well as Diffusion of Innovation, it was important to understand the impact a community had on adoption of technology. It was decided to focus the questionnaire on a progressive community called Parkhurst. Parkhurst is representative of the middle to upper income demographic that this research focused on and it also is home to residents who have been exposed to community technology projects so they should be more au fait and possibly more willing to adopt new technology than other residents and communities. Parkhurst is not only known for its trendy appeal it also has a very active village-type atmosphere and a diverse yet integrated community. It has been a suburb that took the initiative to start its own community policing initiative; it was also the first community-driven suburb to roll out fibre-to-home technology successfully; and it is now focusing in on a green approach to living with its Go Green initiative.

A challenge with this survey approach was the rate at which social media evolves, which meant that the content and questionnaire was not top of mind for very long and so numerous attempts were made to get people to respond to the survey. The take-up of the survey was fairly good the first time it was published, however those responses dwindled over time. The researcher had to re-publish the request five times in order to reach the desired target.

The "I love Parkhurst" Facebook group is administered by the chairperson of the Parkhurst Residents association. The ability to conduct research with the Parkhurst residents through this questionnaire needed to be approved by the said chairperson as well. Once the approval was given, the chairperson publicly endorsed the study on the Facebook page, which certainly made a difference to the attention given to the questionnaire.

The questionnaire was an internet mediated/web-based questionnaire on Survey Monkey and was aimed at the 9 448 members on the “I love Parkhurst” page. A digital team as well as the members themselves closely monitor the content - if the content does not belong on the page, it is quickly highlighted and removed. Fortunately, with the endorsement and topical nature of the survey, people were not perturbed about completing the questionnaire.

This selection approach went a long way to improve the level of responses and the level of confidence that the correct person completed it, as they were members of the study areas community group.

A questionnaire, according to Saunders et al. (2012) should be no longer than six A4 pages, However for this particular questionnaire and its purpose of gaining a better understanding of consumers attitudes, it was limited to three A4 equivalent pages to improve the level of response. The targeted response rate was over 0.5% of all the members and 0.65% was reached.

4.3. Population and Sampling

4.3.1. Population

The population included all middle to upper income households characterised by a minimum monthly income of R19 000.00, and their relevant members/individuals of the decision-making unit. Another characteristic of the population was that they needed to receive power from either local municipalities or Eskom as their primary supplier of electricity. Qualifying questions to determine this were included in the questionnaire and the majority of the respondents met these criteria. Due to Parkhurst having over 3 000 residents that had employment, the average household income ranging between R400 – R600K and the majority owning their homes, the population and research requirements were a match.

4.3.2. Sampling

In the case of a qualitative study such as this research project, there was less of a need to draw statistical inferences from a probability-based sample and more of a need to explore the research questions and gain theoretical insight into the particular subject

(Saunders et al., 2012). It was for this reason that non-probability sampling was used to select the sampling units (Saunders et al., 2012).

A purposive approach to sampling was used and the most appropriate technique identified was the homogenous purposive sampling approach, called judgement sampling, for the given, in-depth requirement of the research (Saunders et al., 2012). Judgement sampling was the appropriate selection as the researcher only wanted to conduct in-depth interviews with people or companies that satisfied a certain criteria (Sibona & Walczak, 2012).

There were three separate sampling frames identified, namely solar practitioners (in-depth interviews); decision-makers in households (web-based questionnaires); and local government representatives, community leaders and South African energy experts (in-depth interviews). According to norms in purposive sampling, the minimum sampling size required was to be between four and twelve respondents. This worked as a guideline for the in-depth interviews and a total of nine were conducted. The number of questionnaire responses required was a minimum of 100 and 102 were concluded.

During the respondent selection and engagement phase for questionnaires, the researcher had to look to improve the response rate by providing sufficient information about the study, but also had to remember that being pointed and succinct when asking people to take time was key. As a result, several reminders were posted, and words that made sense and words that maintained simplicity were used. The researcher also made sure to stress that the respondents opinions were very important to the study and would remain confidential and for aggregated use only (Sibona & Walczak, 2012).

A fair number of journals in the health sciences field require that theoretical saturation be criteria to judge an adequate sample size in qualitative studies involving purposive sample selection. This approach was used as a guiding principle and it is described as the milestone where no additional data are being found. This point generally occurs prior to conducting 12 interviews. In this case of the in-depth interviews, it occurred after nine interviews (Guest, Bunce, & Johnson, 2006).

4.4. Data Analysis

The data collection was done through in-depth interviews for which an interview guideline was developed and used to probe the respective respondents when necessary. A professional company called Admin Assist was used to transcribe the qualitative data from audio files to text. In order to analyse the qualitative data collected, the researcher had to identify key themes from certain points raised or quotes made by the respondents and then code them. These are discussed in the findings section of this paper. The coding assisted in identifying relevant themes, (Saunders et al. (2012) and ATLAS ti software was used to make this coding process more manageable.

During the preparation of the questionnaires and in-depth interviews it was identified in the literature that challenges may exist in the analysis of data from a mixed-method design, due to the difficulty around the actual merging of quantitative and qualitative data. The researcher looked for trends in the quantitative data and aimed to merge it with themes in the in-depth qualitative feedback. This was done by describing the quantitative data first and then discussing the qualitative data and looking for themes (Creswell, 2013).

4.5. Research Limitations

The sampling technique selected, called Homogenous Sampling, a purposive technique, depends on the research questions and is driven by research objective – a note to understand is that the sample may not be statistically representative of the population (Saunders et al., 2012). Due to the limited amount of time and possible accessibility issues, the sample selected does contain some biases and caution of these elements will need to be factored in.

Another potential limitation of the research approach is that of interviewee bias, otherwise known as response bias, as mentioned above. This occurs when respondents have certain perceptions about the interviewer or the topic and due to the explorative nature of an in-depth interview may find the probing intrusive. While conducting the in-depth interviews, the researcher was cautious to avoid leading and also looked to prevent contributing to the interview too much. Intrusive questioning was identified as something to look out for, especially when discussing issues such as

energy-efficient behaviour or finances. This could have led to the respondent openly refusing to discuss certain issues or partially answering questions and telling the interviewer what they thought he would like to hear (Saunders et al., 2012).

5. RESULTS – QUANTITATIVE QUESTIONNAIRE

5.1. Introduction

This chapter describes the results that were obtained through the data collection process, as highlighted in the previous chapter. The data collection process was both quantitative and qualitative in nature; this is known as a mixed-method approach.

5.2. Results of the social media questionnaire survey

The questionnaire was developed to ascertain the opinion of the residents towards: (a) the financial impact of load shedding; (b) drivers of decision-making; and (c) motivations regarding the adoption of solar technologies.

The results have to be read in conjunction with the results of the qualitative in-depth interviews, undertaken with key industry stakeholders. The questionnaire had two broad categories: (a) demographic information and (b) the impact of load shedding, renewable energy sources being used, and the influence of the community.

The questionnaire collected data on the following:

- Household structure
- Supply and cost
- Load shedding occurrence and its impact
- Alternative energy sources used in households
- Motivation to use the alternative energy sources
- Perceptions of supply and social influences.

5.2.1. Household structure and make-up

From a drop-down list the respondents were asked to select the structure of the family make-up. The results can be seen in Table 5-1.

Table 5.1: Structure of family unit

Family Unit Type	% of Total
Married - with dependants	56.57%
Married - no dependants	24.24%

Single - no dependants	12.12%
Single - with dependants	7.07%

The results shown on Table 5-1 indicated that just over half of the sample was married with dependants, with the next largest contributing group being married couples without dependants. This is relevant when looking at Table 5-2 which indicated how these family units rated the degree to which solar energy would be a necessity for the future on a scale of 1 – 5, with 1 being “highly disagree” and 5 being “highly agree”. Their responses showed that regardless of their life stage, the majority of the respondents thought that solar was a serious option to explore.

Table 5.2: Is solar energy a necessity for the future?

Rank	Married - with dependants	Married - no dependants	Single - no dependants	Single - with dependants	% of Total
1	0.00%	0.00%	1.06%	1.06%	2.13%
2	2.13%	1.06%	0.00%	0.00%	3.19%
3	5.32%	4.26%	2.13%	0.00%	11.70%
4	18.09%	6.38%	2.13%	0.00%	26.60%
5	29.79%	12.77%	7.45%	6.38%	56.38%

The respondents were also categorised by their level of household income; Of the 102 respondents who answered this question, 44 indicated that they had a monthly household income greater than R75 000 per month. When looking at ”households with dependents” versus “households without dependents”, it seems that solar energy, as a necessity for the future, was more of a priority in the households with dependants. This variance required more statistical significance testing so a two pair hypothesis, T test, was used.

Statistical Question: Are the ratings of households with dependants significantly higher than households without dependants?

Research Question: Do respondents with dependants think that solar energy is more of a necessity than those respondents without?

H0 $\mu 1 - \mu 2 \leq 0$

H1 $\mu 1 - \mu 2 > 0$ T-crit = 1.761

Given that:		With Dependants	Without Dependants
	x(bar)	4.37	4.22
	s	0.90	1.02
	n	64.00	37.00

t-stat	0.7400

Statistical conclusion: Since the T-stat falls within the region of non-rejection, there was not enough statistical evidence to reject the null hypothesis H_0

Research conclusion: There was no sample evidence to show that a significant difference existed between respondents with dependants who ranked solar as a necessity in the future higher than those households without dependants.

Table 5.3: Number of people per household, by income brackets

Monthly Income	Person: 1	Persons: 2-4	Persons: >5	Total per income band
< R25 000	1	2	2	1
R 25 001 – R 35 000	1	10		1
R 35 001 – R 45 000		5		
R 45 001 – R 50 000		8	3	
R 50 000 – R 75 000	4	14	4	4
> R 75 000		34	10	

The majority of the respondents' households are comprised of two to four occupants per home, with very few single occupants per dwelling within the sample.

Table 5.4: Different income brackets response to solar energy a necessity for the future

Monthly Income	Highly Disagree	Disagree	Indifferent	Agree	Highly Agree
< R25 000	20.00%	0.00%	0.00%	0.00%	80.00%
R 25 001 – R 35 000	0.00%	0.00%	20.00%	20.00%	60.00%
R 35 001 – R 45 000	0.00%	0.00%	20.00%	40.00%	40.00%
R 45 001 – R 50 000	9.09%	0.00%	0.00%	54.55%	36.36%
R 50 000 – R 75 000	0.00%	0.00%	9.52%	33.33%	57.14%

> R 75 000	0.00%	4.76%	14.29%	21.43%	59.52%

The majority of respondents (62%) fell into the two upper categories namely R50 000 – R75 000 and >R75 000. The lowest-represented income bracket was R35 000 and below, however this bracket still felt that solar energy was more of a necessity than the middle income brackets.

The two middle-income brackets of respondents that felt solar energy was less of a necessity, given the future outlook for residential properties. Of the 62% majority (i.e. >R50 000 monthly income), the over R75 000 category made up the majority. It was respondents from this upper income bracket who highly agreed that solar energy is a necessity for residents.

Table 5.5: Alternative sources by family structure

Renewable source	Married - with dependants	Married - no dependants	Single - no dependants	Single - with dependants	% of Total family structure
No alternative	16%	20%	47%	8%	19%
Gas	43%	37%	27%	50%	40%
Generator	13%	14%	7%	17%	13%
Solar	19%	20%	0%	17%	17%
Wind	1%	0%	0%	0%	1%
Battery back-up/Inverter	6%	6%	13%	0%	6%
Other	1%	3%	7%	8%	3%

The most favoured, alternative source of energy is gas (see Table 5.5), although it was not determined if this is bottled LPG gas or municipal piped gas. The second largest selected category was comprised of respondents with no form of alternative energy source at all and was mostly represented by households that were not married nor did they have dependants. Like the other family structure categories, the most favoured alternative source of energy amongst the singles with no dependants was gas, followed by battery back-up solutions. Where solar energy was most prevalent was in households with married couples as well as occupants with dependants.

5.2.2. Supply and cost

The second part of the survey aimed to understand at a very indicative level what the respondents were spending on electricity and who they were purchasing it from. As indicated in Table 5-6 below, just over 80% of the survey respondents had their electricity supplied by their municipality and only 19.15% were supplied directly by Eskom. Although it was highlighted in the interviews that the Johannesburg City municipality experiences less load shedding, due to the Kelvin power station, the survey results did not show this.

Table 5.6: Electricity costs and supplier make up

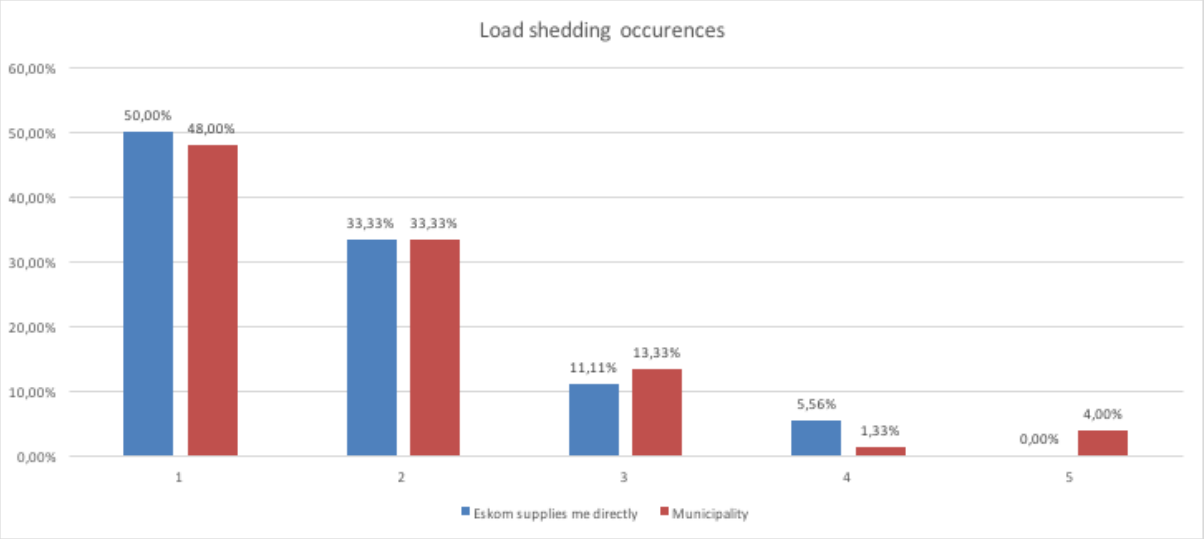
Eskom supplies me directly **(19%)**		Municipality supplies me (**81%)**	
Cost per month	**%**	**Cost per month**	**%**
<R500	2.13%	<R500	4.26%
R500 – R700	1.06%	R500 – R700	9.57%
R700 – R1000	2.13%	R700 – R1000	4.26%
R1000 – R1300	1.06%	R1000 – R1300	13.83%
R1300 – R1500	4.26%	R1300 – R1500	8.51%
R1500 – R1800	1.06%	R1500 – R1800	8.51%
R1800+	7.45%	R1800+	31.91%

The weighted average monthly bill paid by people who are supplied directly by Eskom is slightly lower than the charges experienced through the municipalities, however the difference is negligible at under R100 per month difference.

5.2.3. Load shedding and its impact

Of the 102 respondents, only nine percent had not experienced load shedding, with the majority of the respondents only suffering load shedding once a week during load shedding periods. The respondents who received power directly from Eskom had not experienced load shedding on more than four occasions in a week; whereas respondents who received power from municipalities had experienced this.

Figure 5.1: Electricity costs and supplier make up



Axis Details:

X- Axis: Occurrences of load shedding in a week

Y-Axis: Responses detailed as % of total responses

Of the respondents who experienced load shedding, 27% stated that they had suffered some form of financial loss due to load shedding. The vast majority of the respondents who claimed to have suffered a loss only reported an amount of less than R5 000, however four respondents claimed to have lost in excess of R10 000 due to load shedding.

Table 5.7: Financial loss when load shedding occurs

Financial Loss due to load shedding	# Respondents	% of Total
<R 5 000	21	72%
R5 000 – R10 000	4	14%
R10 000 – 15 000	2	7%
>R15 000	2	7%

5.2.4. Alternative energy being used

The next section of the survey aimed at gathering information about the chosen alternative energy appliances utilised by households. The respondents identified gas as the most commonly used form of alternative energy, with solar geysers as an

alternative source for their water heating requirements. Of the 102 respondents, only 23% claimed to have solar as an alternative source and 14 of the 23 (61%) solar respondents were actually referring to their solar geyser.

Table 5.8: Types of alternative energy

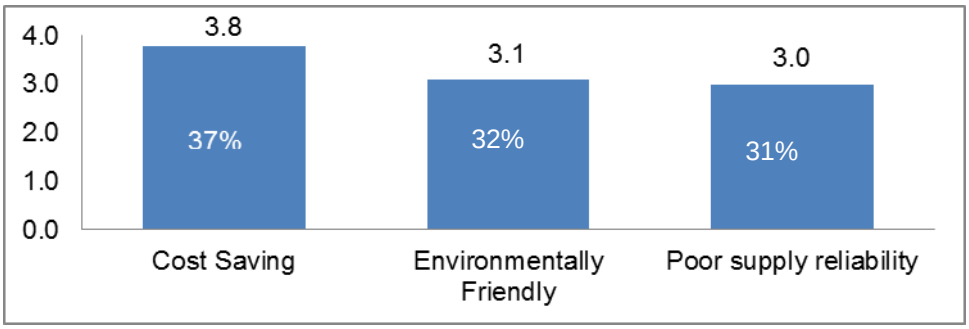
Alternative energy source	Number of respondents	% of Total
Gas	58	52%
Generator	19	17%
Solar	23	21%
Wind	1	1%
Battery back-up/Inverter	9	8%
Other	2	2%

There were 29 (38%) respondents who claimed to have suffered financial loss due to load shedding and of the 29, only six (21%) had alternative sources of energy, namely two respondents with generators and four with solar geysers; none of them reported to have some form of electricity generation or back-up capacity.

5.2.5. Motivation behind adopting solar energy

In order to understand the motivation behind choosing to adopt solar technology or not, the survey asked respondents to rate on a scale of 1 – 5 their reason for either adopting solar technology or their reasons why they have not. The respondents who had adopted solar technology had three reasons to choose from, and the respondents who had not adopted solar technology, had a selection of five reasons to choose from. The results were as follows:

Figure 5.2: Rated (1 – 5) reasons why solar technology was adopted.



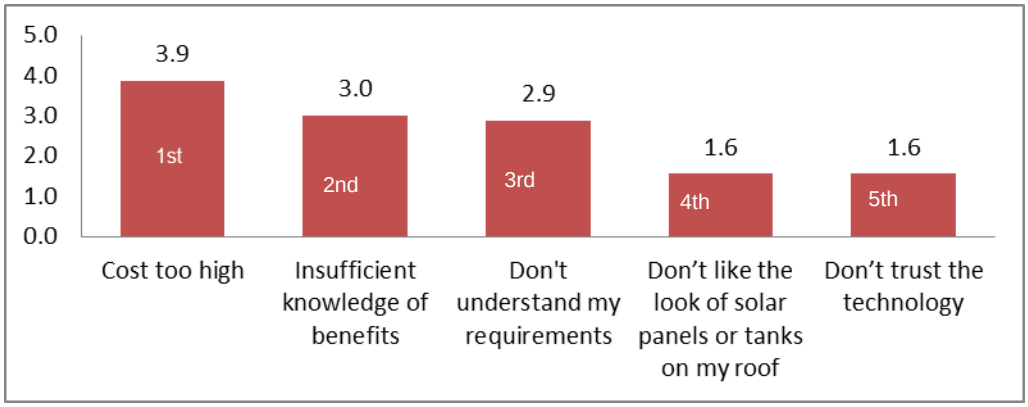
Axis Details

X Axis – Reasons stated for adopting solar technology

Y Axis- The number above the bar is the average rating per category and the percentage in the bar shows the number of respondents as a percentage contribution to that category.

Of the three reasons for solar technology adoption, the highest-rated reason was for cost-saving purposes at 3.8 out of five, and poor supply reliability, which referred to load shedding as the least influential reason for solar adoption.

Figure 5.3: Rated (1- 5) reasons why solar technology was not adopted.



Axis Details

X Axis – Reasons stated for NOT adopting solar technology

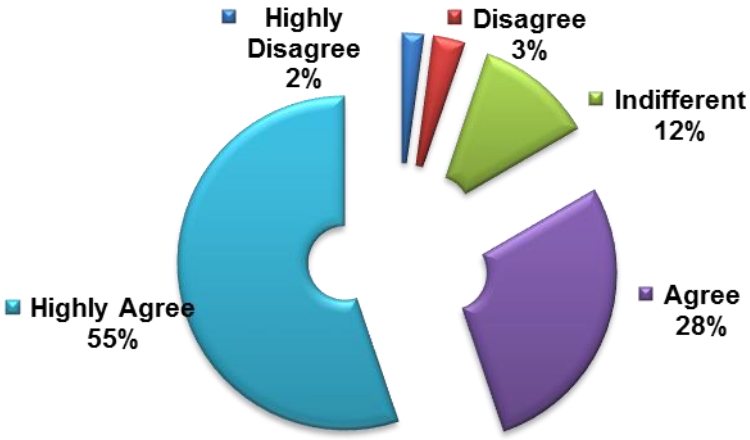
Y Axis- The number above the bar is the average rating per category and the ranking in the bar shows the ranked level of influence each response had.

The respondents who had not adopted solar technology claimed the main reason was that the costs were too high and that they had insufficient knowledge about the benefits. Very few respondents seemed to have a lack of trust towards solar technology and further, only rated aesthetic reasons as 1.6 out of 5 as a contributing factor for lack of adoption.

5.2.6. Future outlook and community influence

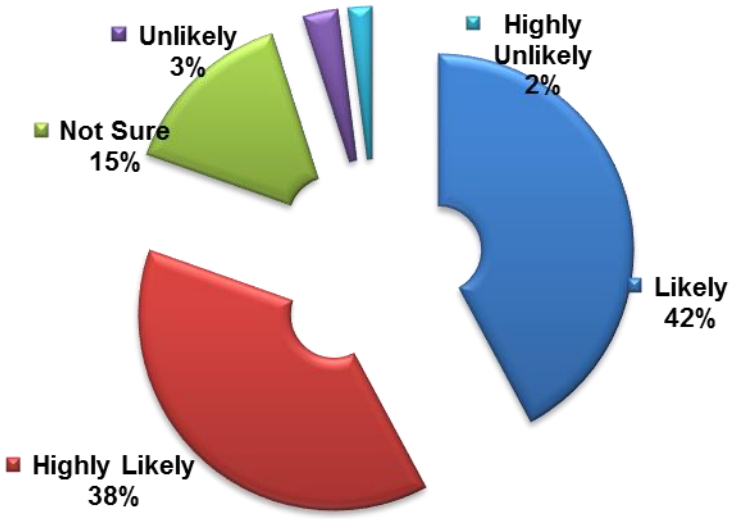
When asked to rate a statement between highly agree or highly disagree, just over half the respondents highly agreed that solar energy is a necessity for residential properties, given the future outlook, with the other half made up of people agreeing and only 5% of the respondents disagreeing that solar energy was a necessity.

Figure 5.4: "Solar energy for residential properties is a necessity given the future outlook?"



The Diffusion of Innovation theory states that observability and trialability are key influencers in the adoption process and it is for this reason that the survey asked respondents to rate on a scale the likelihood of them adopting once seeing solar technology work in a community or friendship circle. The results showed that 80% of the respondents are likely to adopt solar technology once having seen it work in a community or friendship circle.

Figure 5.5: Likelihood of adoption if technology is seen to be working in communities.



5.2.7. Summary of findings

The social media-based questionnaire focused on a community classified as upper LSM and thus well off in comparison to the South African average. Although most acknowledged that solar is an alternative energy source that should be adopted, very few have actually switched over to it. This may be due to the low impact of load shedding, but it is apparent that the biggest challenge is the cost of solar and the respondents' level of understanding of the technology.

6. RESULTS – INDEPTH INTERVIEWS

6.1. Introduction

In order to get a valuable distribution of perspectives, stakeholders representing the following areas were identified:

- Business and residents association
- Property brokers
- Solar energy practitioners
- Local government councillor
- Energy sector analyst
- Equity fund managers
- Financial institutions
- Ex-Eskom technical staff member
- Parkhurst resident & researcher

Table 6.1: Respondents' category and numbering

Category Name	Naming Key	Respondent No.
Property Broker	PB	1
Energy Analyst	EA	2
Local Government	LG	3
Residents Association	RA	4
Energy Industry employee	IE	5
Parkhurst Area specialist	AS	6
Financial institution	FI	7
Private Equity Funding	PE	8
Solar Practitioner	SP	9

Once the interviews were conducted and transcribed, they were analysed for certain themes that were most prevalent across all the respondents. These themes were consolidated into four main categories with a further three main supporting categories.

In Table 5.9 it is evident that the distribution of how often the respondents mentioned content within these categories.

Table 6.2: Categories discussed

	PB	EA	LG	RA	IE	AS	FI	PE	SP
Community & Consumer awareness	13	23	39	37	6	11	24	18	27
Environmental influence	0	6	5	1	1	1	0	2	3
Financial	14	30	32	16	4	6	25	28	9
Government & Institutions	7	57	55	15	6	2	5	20	16
Power situation	0	9	7	2	0	2	3	4	5
Solar compared to the rest	2	30	4	6	1	0	1	8	2
Technical Knowledge	7	7	19	12	6	8	4	2	10

6.2. The Power Supply Situation

The current energy situation was a key discussion point for most of the respondents, with varying opinions about the current supply side status with respect to Eskom, as well as the impact that load shedding and price increases have had on consumers and South Africa. Thus, the responses were mixed in that some felt the situation was not severe enough to push people to adopt alternatives. That is, some were of the opinion that adapting to cope with load shedding is fairly easy and with the right amount of forewarning the respondents and residents can plan around it. One respondent commented about the load shedding warnings that are issued by power suppliers such as Eskom as follows: *"They have changed those schedules so you typically, we now get load shed maybe one or two nights a week and all of that has gone to ensuring we do not really have many (outages), it is not a huge threat anymore, it is not a big thing to plan every 24 hours." [Respondent 3].* Despite this opinion, the load shedding schedules were not always communicated properly which made it difficult for residents and local associations to plan ahead. Others felt that load shedding is a strong motivation for people to adopt solar energy. For example Respondent 6 stated: *"I think particularly with what is going on with Eskom; there is already an open market to adopt alternative technology."* While these views portrayed a slightly tempered view about energy availability, it was noted that the reduced and planned load shedding might be giving people a false sense of security. This was highlighted by Respondent 2: *"Which is exactly what happened in 2008, by the way, after the world bubble burst and the demand was down and that and everybody becomes complacent again."*

Further, some respondents said load shedding had not been as bad as it could have been, due to a few reasons:

(1) Poor economic growth: *"Ja, look, in a way there has been a few things that have come together that have worked in favour of not having load shedding, you know, to avoid load shedding. The most important of which, but not the only one, is the weak South African economy, the weak demand for electricity which is also fuelled by the commodity prices in China and China's economy." [Respondent 2]*

The solar industry suppliers agreed that poor economic growth helped the country avoid load shedding, but expressed concerns should the economy improve then load shedding would return: *"We forget very quickly, but I do believe that we are going to go into an interesting period, where we are going to be very sorely reminded of why we need solar energy. I think my conviction is the fact that we are going to have some real trouble in 2016, subject to a growing economy, and at that point we will not be able to avoid an alternative route." [Respondent 9]*

(2) Seemingly better planning*: "I mean I do not suppose you know how long this will last; they have spoken about two to three years that we should expect load shedding, but, I mean, that was, if you have seen the last 60 days, it has been fairly small." [Respondent 2]*

There has been an improvement in the supply of energy and Eskom's new CEO was credited for the improvement; however there is still scepticism about when, and if, the situation will be fully repaired: *"I sort of think, well, maybe we will, but it is going to come at a cost and maybe only in 20 years' time, maybe in two, but maybe in 20." [Respondent 4]*

(3) *Demand side management: "People are not using electricity because Eskom constantly urges them not to, because not only that, there has been load shedding this year that has reduced the demands for electricity so there are a lot of things that are working, but at the moment load shedding, I think, is not happening for the most significant reason is the lower electricity demand." [Respondent 2]*

There were multiple points raised that drove home the "positive" impact load shedding has had on the adoption of solar energy: *"I mean load shedding is brilliant, it just kicked me into doing it, you know, this month instead of next month." [Respondent 4]*
"For me, after we had those two outages over this year, where the fire appeared at the

park and then the replacement, just the peace of mind that comes with not having to worry." [Respondent 3]; and lastly, *"Ja, and so you need actually more of those kinds of things to happen in Parkhurst to actually get people to go onto load shedding mitigation." [Respondent 5]*

A slightly more indirect view was that it may not be alternative energy per se that households are looking for; they are merely looking for a way to reduce the distress that intermittent or outright lack of power brings: *So, I think what stimulates the conversation it is probably not the immediate thinking to go to a solution which is alternative energy, but it is going to a solution that takes away the pain that they are going through." [Respondent 7]*

While these views promoted the adoption of solar technology, more than one analyst did not think rooftop solar solutions were the answer to the energy crisis, especially for residential properties, due to the financial justification still not making sense:

"Let me just say, in the era of load shedding, do you need solar panels or do you need a power wall from Mr Musk or do you do not actually need the solar side of things; you charge it when you have power on the grid and when the power fails as a result of load shedding, I am talking load shedding now, we are talking about a two-hour kind of a window, so all you are looking to do is backup your house, to be able to continue your house for two hours and then the power is going to come back on again and you can charge again and then the next day when you have it, so it is fine, but I do not see that solar power is the answer for load shedding." [Respondent 2]

"If you are talking about much more extended blackouts like, if you want to be able to ride out a 12 hour thing, which has nothing to do with load shedding, the distribution main, then Mr Musk's solution is going to be too expensive and so, by the way, is solar, because it is going to be even more expensive." [Respondent 2]

"I do not think the economics is right, even in the case of load shedding, you know, I do not think that solar is the answer to load shedding - it is like, do you remember at the traffic lights, there was big talk, they were going to have solar powered traffic lights all over Jo'burg, the minister said they were going to do this roll it out around Jo'burg, it never happened. Why? Because it makes no economic sense, they were doing this, because of load shedding, why have these solar panels? You just charge batteries

from the mains and you have a big battery there at the traffic lights, it is like a big UPS and you charge up the battery when the power is on, when the power is off you power the streetlights from the battery and you just change the light globe to more efficient light bulbs." [Respondent 2]

The same respondent highlighted that solar energy compared to base load energy is incorrect as they cannot satisfy the same need equally:

"So you cannot compare the two, because one is what I call maybe intermittent or mid-merit sort of generation scheme and the other one is a base load scheme and you have to have the base load scheme to provide backup to the intermittent schemes. So actually, the costs of solar PV are not the full costs, there are other costs that you should be adding."[Respondent 2]

The second respondent identified two different approaches to solar energy, one more motivated by cost and the other one described how to mitigate load shedding impact without a panel array.

"So the way I see it there are two markets here - there is either you are selling solar panels on people's roofs and people will buy it because they can get electricity from those solar panels cheaper than they can from the grid, okay? For that you need this big funding structure and leasing, and they need to be able to pay for it over a long period of time." [Respondent 8]

"Or you are selling grid reliability where people are then buying solar panels and batteries, but actually forget the solar panels you do not need them all you need is just the batteries and inverters sucking from the grid and then you have got a backup system, but then you might as well get a generator, because the upfront Capex is lower. Over a longer period of time a generator is more expensive, but to the average person who is not going to get finance on batteries, they would rather get a generator." [Respondent 8]

6.3. Environmental issues

The respondents were fairly uniform in their opinion about the impact that environmental considerations have on solar energy purchasing decisions, namely, very

little. One respondent stated: *"Let us reduce coal pollution or something, you know it is more an after the fact justification." [Respondent 1].* Another claimed: *"I do not think we are as conscience about green electricity, you know, as they are in Europe where, you know, people are very, very, very aware." [Respondent 3]*

One respondent even highlighted that he did not like the fact that solar energy sits in the "green" category because it makes it a more difficult selling point: *"I think, a lot of people think it is great, and secondly I do not like the fact that it is renewable and that it is green, it is a very difficult sell point." [Respondent 8].* However, this same respondent went on to highlight some of the benefits being experienced by the Renewable Energy Independent Power Producer Procurement Programme (REIPPP) and its positive impact on the social, economic and environmental elements: *"South Africa's renewable energy is the cheapest in the world and it is because of the REIPPP process, all the projects have to make commitments to socioeconomic development, enterprise development, local content, BEE, like it is quite a, and of course the cost of doing business and construction in South Africa, you know, is more expensive than in some places, but because of the process, because it is really, it is so competitive, it has driven the tariffs down." [Respondent 8]*

A particular response showed a glimmer of environmentally-focused decision-making, however, it was a lone comment amongst the rest. The respondent highlighted that it is important to *"be mindful in terms of what you do, what you consume, what you do not consume, all of those, because every decision you make has an impact. It might be a political impact, it might be an environmental impact, but there are always consequences to decisions you take." [Respondent 4]*

6.4. Financial considerations

When interviewing the various respondents there were a resounding number of comments about the financial aspects that are influencing the adoption of solar energy. The areas commented on included both commercial, government and residential. For clarity purposes, the financial motivations or drivers can be split into two categories, namely: (a) Financial business case for suppliers and buyers of power – including a view on tariffs; and (b) Access to finance.

6.4.1. Business case for solar energy – A view on tariffs

Eskom is South Africa's electricity utility supplying close on 98% of all the power to the country. Respondents had different views on the performance of the utility but when stripping away all the emotionally motivated reasoning, the utility still needs to operate in a way that makes financial sense. There are European countries that have progressed further down the supply of renewable energy journey, in that these countries have vastly improved offers for residents' compensation both financially and on interest rate relief. This is evident in the following quote by Respondent 3: *"In France, if you wanted to put solar in or you wanted to put grey water system in or you want to put double glazing on your windows or whatever, insulation roof, you go to the bank, you get an interest free loan to cover it, you know, and the installation of it, comes off, so you pay for the material, the installation comes off your bill, you get a rebate on your property tax and the sales tax, instead of you paying 20 or 21% odd, it comes down to about 5 or 6%, because you are doing stuff for the environment."*

A different respondent highlighted that the motivations behind some of these European tariffs were not financial: "*In other countries, you know, like Germany for example, these tariffs, feed-in tariffs from residential users were highly subsidised by government in the sense that they, you know, they were much higher than market price, cost of generation by the utilities, but I presume the lawmakers just sort of set a feed-in tariff and told the utilities that is what you are going to have to buy and that is what you are going to have to pay and remember with solar at domestic level it is generating most of the electricity when the utilities do not need it." [Respondent 2]*

One respondent noted that Eskom is in the business of selling electricity for profit and currently solar energy is more expensive than energy generated from fossil fuel sources: *"So obviously suppliers like the municipalities and Eskom who supply electricity to some domestic, residential users, you know, do not want to give a tariff that pays people for electricity that they generate, which will ultimately mean them supplying less electricity; and they are buying electricity that are not themselves, so there is a clear business case, you know, that they do not want to buy electricity from people who are not themselves. They are in the business of generating electricity and selling electricity for money, so they buy it from residential users they are going to lose revenue on their business." [Respondent 2]*

An energy analyst commented on the production costs of fossil fuel-based energy and solar-based energy and noted that one needs to be sure to consider the financials prior to assuming that solar is a better option on all counts: *"But more than that is the question, at what price they (Eskom) would have to buy it, so they will see, you know, that their average cost of generation is, let us say, 60c a kilowatt hour or whatever and at residential level, if they were going to buy electricity from residential users, maybe the price is going to be R1,30, R1,40, R1,50, per kilowatt hour, so they are going to have lots more costs and they are going to lose sales, you know, for them it is not a business model that appeals to them, because they are trapped in a certain paradigm doing business." [Respondent 2]*

Another respondent also remarked: "*The other thing you need to look at is the electricity tariff, so I mean this kind of a model where you are selling electricity to the customer only works if you can sell it more cheaply than they are currently buying it from the grid." [Respondent 8].* The respondent went on to describe how even the European countries are beginning to ratchet back the level of tariff allowances and payments that are being awarded for generation of power through solar technology: *"Of course, the people are now saying jeez this is costing too much and who is paying, so that whole question of feed-in tariffs has not been widely accepted in South Africa and I do not think the average mass person in the street, you know, is prepared to pay a major premium for renewable energy." [Respondent 2]*

Referring to the South African supply the respondent said: *"I do not think Government is prepared to subsidise it; Government do not have the money and I just do not think that that business model or feed-in tariffs at a subsidised price is going to really fly both at government level and at consumer level." [Respondent 2]. "You should not, you should compare it with perhaps their (Eskom's) cost of new generation, because this is new generation but the reality is that Eskom has got an existing fleet and it has got a mixture of sort of old, medium and younger power stations and they do have an average cost of generation; you can see it from their financials, it is the cost of sales, it is the sales, you know, it is the overheads and you can work it out, rand per kilowatt hour, that is what it costs them to deliver electricity in South Africa on average, so, you know, that is it and if you have got that existing fleet and you have got the benefit of an old, medium, new mix then they are going to just say it does not make sense." [Respondent 2]*

The respondent mentioned that feed in tariffs do not makes sense for the additional reason that residents will be able to generate solar power at times that the utility does not actually need it; however, this is not necessarily the case with commercial applications. The business case from a commercial point of view makes sense because the profile of generation matches the profile of commercial usage.

A second respondent also highlighted the commercial, roof-top solar business case by specifying retail commercial is ideal: *"So you know net metering? Or wheeling, okay, so in the States obviously like if there are panels on somebody's house, he goes out for the day, he is earning money the whole time, because he is being paid for it. In South Africa, if those panels sit on my roof, if I am not there using them to the maximum, then I just lose that energy, and because the usage profile of a residential user is like this (Concave over a daily time period) and the sun is like that (Convex over a daily time period), there is this big fat gap of electricity which is basically going back into the grid for free, conversely the best customers for solar PV are commercial, but not all commercial, retail outlets, because in an office block you have got your weekends where nobody is using electricity." "But retail outlet you have got, you know, basically when the sun is shining they open, so you will see all the biggest installations in South Africa, like up to like 1.5 megawatts now, all of them are on big retail stores and that is how it started in the States as well." [Respondent 8]*

What the respondents did highlight is that with increasing power generation and distribution costs there will come a point when the cost of solar is more on a par with fossil fuel generation sources. This is evident in two different respondents' comments: *"The economics, when do they change? I mean obviously the government and Eskom are producing at a particular number, that number is rising, so if that number is going to continue to rise that will change the economics." [Respondent 2].*

Further response was: *"To start, your grid electricity is currently cheaper than what you can get from solar panels on the roof, even in the middle of the day. Then, because solar panels become cheaper and the grid becomes more expensive, at some point they cross and it becomes cheaper to have panels on your roof. So that point will happen and I have actually done the models on some commercial and residential side, and the commercial side, just the panels alone, just as a cost saving tool, without batteries is somewhere between 12 and 18 months depending on the particular tariff that the consumer is paying, but it is between, you know, either the next tariff increase*

or the one after that is going to put us to the point where it starts to make financial sense." [Respondent 8]

One respondent, although a lone voice, commented: *"I think too many people to see power costs increase to the extent that they have, to see the supply being less reliable than we had expected it to be, all of that has come as a shock, because we have been very complacent, we have not appreciated how cheap our electricity has been and, frankly, still is, in many respects. So, I think we still do not appreciate how cheap our electricity is." [Respondent 4]*

The cost of generation is a variable that influences the supply side. Similar supply side influence will come from developments in technology, as was also highlighted. However there is still a question outstanding with regard to the penetration depth across the lower level LSMs: *"Solar PV panels have to come down in price and I think, you know, the battery technology is starting to change and improve now. I think it is also going to be driven to quite an extent by the manufacturing of batteries in scale, I mean serious scale. When you are talking about the electric car market, that gives a huge base load made in exactly the same mega factory, now we double the market size so the point is they are starting to talk really big number, really big numbers and maybe this is going to bring down the price and change the gambit however battery technology is a reasonably slow moving progressive technology change, it is not like electronics which have chips which you get these most amazingly fast changes." "But certainly, I think battery technology is going to start to come in, especially in higher income applications and especially in the first world, but I am not so sure about, you know, the mass market in South Africa, which is at a level of income very much lower than America or Europe, so I think in South Africa we are going to see niche applications, at the upper income levels, where people might do this for ideological reasons or because they are fed up and they can afford to do it and they will do it, but I do not think it will become a mass market thing yet." [Respondent 2]*

Although there are varying opinions with regard to which market benefits from solar energy and at what cost, the following comment made by one of South Africa's leading energy analysts, summarised the structural change that is underway in the South African energy industry: *"And the price will go up some more, which makes the solar option even more viable, so more people switch and then they have to put the price up some more and you get into this cycle of upwards prices and downward sales and all it*

does it drive your customers away." [Respondent 2]

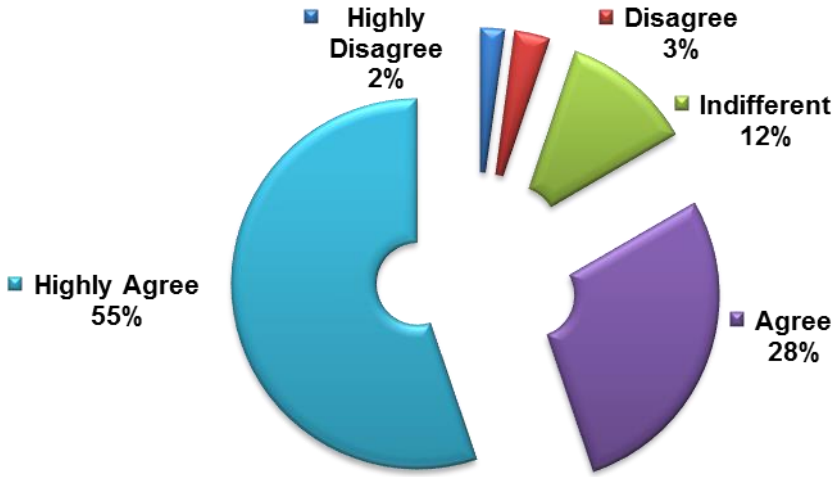
From a consumer or household's perspective there are financial benefits that extend beyond the current questionable business case of solar. These benefits include the additional value that is experienced on a property as well as the saleability it brings. One respondent, who is in the property industry, stated that the newness of the technology for residents in South Africa may not be fully quantifiable but it does stand out for buyers, most notably explained by the following comment: *"Solar panels and geysers are what I am referring to, are they going to give you R200 000 back? Not necessarily, but it is going to make your house more attractive to sell." [Respondent 1]*

"So it is quite difficult to give a quantity or a quantitative figure as to what your actual realtor value increase is, but if people go and buy a house they have tick boxes, and this is one." [Respondent 1]

6.4.2. Access to finance

Consumers, regardless of business case logic or the specific rands and cents, highlighted that solar technology is something that they feel is a necessity in South Africa's future, as can be seen in the pie chart below.

Figure 6.1: "Solar energy for residential properties is a necessity given the future outlook?"



This made it important to understand the level of readiness and appetite there was for financing solar energy technology, both from a resident's point of view as well as the financial institutions. Financial institutions stated that the subject of renewable energy is

very topical and that it occupies a large amount of their conversation and strategy planning. A financial institution representative purported as follows: *"I can tell you from the banks' perspective alternative energy is a very popular category that we put out there, because we also know it is a very socially-relevant category; it will remain a top priority for us." [Respondent 7]*

"If you look broader than just our business, right now I spent time with varying business units internally and I must be honest by saying that this is probably one of those categories that you can see was very consistent in everyone's conversations about where's the PV framework going and investing in something that is relevant to customers is important. It is relevant to an individual customer, it is relevant to a business customer and it is relevant to a corporate customer. Everyone is looking for solutions here, because everyone is impacted, it is a very socially relevant topic." [Respondent 7]

The financial institutions question the affordability and financing percentages they are being asked to give, but in return they question the solutions themselves: *"Then we can also say why do we not just cut the solution with 40%, I am telling you now that you do a bit of research with consumers and ask them and they see this investment of R150 000; they are very reluctant to go there, that is a big thing, there is still two parts of the coin for me, the one is about the financing piece and the one is about the solution piece." [Respondent 7]*

The financial institutions also take a view of total affordability against priorities in consumers' lives, (Respondent 7) noted: *"Depending on the customer profile that you are dealing with, people have, depending on the life stage that they are on, people have a number of priorities. So it would obviously influence also your behaviour to society whether you want to make purchase or an investment into this (solar) or not. So I do believe it is about access to funds, but also about the type of customer that is in a position to make this a priority."*

The financial institutions have offerings for consumers to access finance that can be used for solar technology; however, they are in the form of very standard loan offerings. One institution has numerous options, which it shared during the interview; these are:

- *Personal loans (unsecured) – matching any other better offer from their competition*
- *Credit card facility – prime interest rate for the first year of the loan*
- *Utilising equity on your house – reassess finance if no flexi facility, similar interest rate*
- *Overdraft on cheque account – interest rates around 14 % -16%*

[Respondent 7]

Although topical and viewed as socially relevant, the institutions indicated that there is no pre-structured offering and one reason could be that the adoption or take-up is just not where it needs to be: *"Taking it up, is not mainstream yet, it is a very particular group of people that find this very relevant and they are making an effort to invest in this, The volumes there are obviously not that high."* On the financial institutions offerings, this respondent commented as follows: *"I do not think we have a specific loan proposition to your questions that makes provision for something that is almost pre-packaged as a solution, financing solution for that particular purchase, because we see that the adoption and take-up is not there yet to justify a unique proposition on its own." [Respondent 7]*

A view from the financial institution was the level of indebtedness being experienced by individuals and the levels of affordability for purchases on a credit basis: "*The other thing I wanted to mention obviously is that as part of the complexity that you are obviously sitting with is that you also have to appreciate people's indebtedness or their ability to be able to take on debt; that is, the one thing that will influence access to funding is also access to credit, because a lot of them, most of them would be on a credit basis." [Respondent 7]*

When interviewing the residents or residential associations it was highlighted that there are not really accessible or innovative ways to finance solar technology, as indicated in the quote: *"There is the will, I do not know if it is a marketing will or an emotional will whatever, there is a will to provide funding, but within the banks, from what I can see and from what I understand, the risk and credit teams within the banks look at these things from traditional and perhaps conservative perspectives - their risk committees perhaps still look at these things as standard asset finance and that is it." [Respondent 4]*

However this view seems to be changing, according to one of the respondents: *"Nedbank, with its 2030 initiative, has started looking at a very different way of doing this, but they still need to translate that into a banking product that you and I have access to, that allows us to finance renewable energy if not only at prime rates, but perhaps at a very, very low interest rate." [Respondent 4]*

However, this view was not supported by two respondents who, in their personal capacity and representative capacity, claimed that access to finance is still very difficult. They commented: *"It is hard enough to get the bonds; actually, if you really want to know, it is hard enough just to get the finance." [Respondent 1];* and, *"You would think it would be easy to get a mortgage, to just bump it up and get your quotes, your seventy odd eighty thousand rand, but it is such a mission to get it, you can go to the banks and get a loan and remember they charge you 15% to 18% interest." [Respondent 3]*

One respondent felt that a typical individual funding approach to renewable energy was not the outlook for the future. This respondent identified funding opportunities in the renewable energy industry as part of the sector. This is highlighted in the quote below in that the solar industry will end up consolidating and be a majority-leased product or solar utility power sold on to consumers, much like in the United States of America (USA): *"I guess our view on this is that what has made this work in Europe and the States, and particularly the States, is first of all a certain level of subsidy and then secondly, the financial innovation around the business model. You can either choose a PPA, so that is a power purchase agreement. On the power purchase agreement, you actually pay for each kilowatt hour of electricity you use, the lease you pay a fixed monthly amount to have it on your roof and then you use whatever you use." [Respondent 8]*

When probed to better understand these different business models the respondent explained the evolution of these business models by responding as follows: "*There was a big wave of these on the commercial side and then on the residential side, a company called Solar City were the first to offer this and if you look at it now, more than 90% of installations are bought on this kind of contract, at the end of the day businesses and individuals, in general, do not have the Capex to put down a system on their roofs, especially for something which they are used to paying for as a basic*

consumable." He also went on to say the alternative energy investing that his firm has done has been good and that *"there is big opportunities for investment and returns in South Africa have been very good." [Respondent 8]*

6.5. Community and consumer awareness

After conducting the in-depth interviews there was a sense that a movement is occurring around solar energy. This is being motivated by a general awareness that is improving and the impact of awareness on the community. It was firstly noted by one of the respondents that the impact of no power needs to be sizeable enough for it to evoke change. He noted: *"Society needs a shock to the system to make the change and if it is too incremental then South African's tend to just absorb the cost and poor service. If electricity costs were to go up by 50% immediately it would influence the awareness and adoption." [Respondent 6]*

A local Parkhurst resident also commented: *"I would say if you could get the two quotes to roughly the same kind of level and understandable, if you could have a kind of a bad period where there have been power outages, Parktown North and Craighall Park are good example." [Respondent 3];*

"If you could get, so you target those areas and at the same time you bring in the banks with you and say jeez, you know, yes we will give it to you at 10%, I reckon you would get a lot more and then suddenly you would reach kind of a threshold where I have got one and the neighbours will come and have a look, and go wow, and how much was it, okay ja, it could be pricey, but... And did you just add it on your mortgage, ja." [Respondent 3]

The comments above summarised factors that would make a difference to awareness of solar energy by highlighting the simplicity and clarity of quotes required, the impact that high levels of outages have on awareness, and how references and word of mouth influence the awareness and understanding.

When referring to the complexity of tariff structures and various costs associated with them, a respondent noted that in addition to the barriers expressed above, the tariff issues also play their part: "*So all these things come into play and you have not really figured that out yet, a lot of those people have not because they do not know about*

these things." [Respondent 5]

Supporting these comments above regarding consumer awareness were the comments from the financial institutions that noted the following: *"There will be two drivers in that, as people experience more discomfort more people will be motivated to do something. Not everyone will have the means to be doing that, however there will be some that will say it is time to invest and let's just bite the bullet. So the more we sit with pressure from what is available from the grid I think the more people will be in a position to say make a decision. On the other side, if we ask ourselves what do we do to get a higher adoption rate, the solutions, it would be I think we need to communicate more to the consumers and tell them about the options and solutions that are available. I think most people do not know, so that is why we as a bank, when we engage we are able to actually send a message to say we know you probably do not know, but we have looked into this and we have some solutions available." [Respondent 7]*

Once awareness was understood via the in-depth interviews, the interviewer asked about the impact a community had on adoption. Due to the study being conducted in Parkhurst, the example as follows was experienced in person by one of the respondents who was involved in a similar roll out of technology in the form of fibre to the home: *"Yes, you literally go to a meeting at somebody's house or a resident association and you arrive and you say oh, let us do this and they say fine, do it. Literally within like 10 days the whole thing had been set up. They had meetings with the residents' association, so from conception to actually finishing the whole suburb was under one year. It is unheard of and the residents' association put out the request for tender, they are the ones who awarded it to the successful company, it was not Telkom or City of Jo'burg or whatever, it was them, they got Parkhurst at the right time and Parkhurst was the ideal place, because there are a lot of people there who are quite wealthy and the current internet infrastructure provider had peed us off so it was like a perfect storm waiting to happen. These guys, the new fibre company, had tried doing this a few years ago and it had not worked as well without the association." [Respondent 3]*

The double benefit was not only the communal approach and its positive impact on action for Parkhurst, but also the speed at which other suburbs were able to adopt this because of the learnings, as explained in a quote by the same person: *"And then once they had done it, once people saw how it was done, once they had learnt from this*

experience of them putting it into Parkhurst and Parkhurst learning from them, it was very much two-way process, then it is easier to sell it to the other suburbs." [Respondent 3]

With the high levels of the fibre-to-home acceptance driven by the Parkhurst Residents and Business Association (PRABOA), they have decided to approach solar energy in a similar fashion, reduce the amount of clutter inherent in new technology, provide information and vet the supplier: *"In a sense, there is too much out there to make it easy for people to understand and that is why in Parkhurst we have gone for two options to begin with." [Respondent 4];* they believe that – *"what is even more important is allowing people to understand how to access the information and how to assess the information."* PRABOA has embarked on a project called Go Green. *"Go Green initiative in a way, does that for the community and for society." [Respondent 4]*

The Go Green initiative is a renewable energy project that encourages, educates and makes renewable energy sources affordable and available to Parkhurst residents. Part of the initiative is to look at community-based solar options. One stated vision is highlighted: *"What we are looking at is to have, for example, solar panels on every single roof in Parkhurst and you have finance company X saying we are going to fund all the players, and sell the power from that, so they will put it on my roof, and I buy the electricity from them instead of from Eskom or City Power and they will make their profits that way." [Respondent 4]*

To illustrate the evolution of residents understanding, the representative from the residents' association in Parkhurst quipped: *"I think it has worked and if you even look at the I love Parkhurst page, when we first started having the load shedding and somebody will say grumble, grumble, grumble, then it was, oh well, I have got the candles ready and the torches, so I am find about it. Then it was I have got a generator and there was a few of us saying do not go generator, get solar, do this, do that, now when there is load shedding, if somebody says they have got a generator, oh, that is very inconsiderate you know, why do you not get at least an inverter, even it is a plug and play, which is not perfect." [Respondent 4]; and, "People's responses have matured quite a lot, because there are those of us who can say I do have solar." [Respondent 4]*

6.6. Technical competence

Feedback from the interviews clearly showed that technical know-how is lacking and that both companies and communities do not fully understand solar technology. An industry analyst who is an electrical engineer summarised the various components required in a solar system while expressing his view that technical competence at a residential level is not where it should be: *"If there is not a feed-in tariff, number one, and all the necessary technical regulations in place, number two, it is not going to happen…at a commercial level it is ready, you are talking about bigger systems, which are connected generally at medium voltage. That means at 6.6 -11Kv sort of voltage level and you have got some measure of technical competence within that commercial operation, maybe it is a building, or a maintenance manager who is responsible for the electricity and the electrical and the pipes and the water etcetera, so you have got some level of technical competence on site where at a domestic level you don't."* *[Respondent 3]*

"In the system you need batteries for battery storage so that whatever you generate during the day you can store, so when you come home at night you have got some power, you are talking about solar panels, batteries and battery chargers and inverters, this is too technical for a house and they do not have any technical people in the house, I mean, most households would have no capability to manage it properly and to maintain it and to make sure it is always working." "So I do not know if we are ready for it at the household level." [Respondent 2]

Another respondent who worked for Eskom for many years claimed that the lack of technical training in the South African education system and the change in technology plays a large role in the poor technical competence evident in society: *"South Africans do not possess the technical mindset and competence that they used to. This is partly driven by the education system; Maths & Science rankings of our learners is very poor. Society is not required to understand mechanical technology anymore as it has evolved to digital technology." [Respondent 5]*

Respondent 5 highlighted the shortage of technical knowledge within Eskom and this was supported by a local government representative as follows: *"The lack of technical expertise in Eskom and government is also a major concern with regards to improving the supply of electricity to South African households." [Respondent 5]; and, "So those*

are the problems and they have also cut staff, I mean they do not have enough staff at City Power and that is the problem, they have to hire contractors to come out to repair things, you know." [Respondent 5]

The impact of poor technical know-how was exacerbated by the fact that solar practitioners in the industry, and even Eskom, are not making it any easier for residential consumers to understand it. This can be seen by two quotes below, the first about understanding offerings and the second about Eskom's billing structure: *"In my opinion, is too difficult or too technical, I think that is one of the problems, it's that they are quite variable and they are offering quite different things and some have good ideas and others not." [Respondent 5];* and, *"Your other problem is everything is so complex. The tariffs are so complex, the charges are complex, the billing is complex." [Respondent 3]*

Respondents from the solar industry also stated that both the market and the suppliers were not as knowledgeable on solar as they should be and that the responsibility for the education of suppliers and consumers would have to fall on the shoulders of the industry: *"So many people can tell you of friends who got an installation that is not working, people are just extremely naive. I would speak to directors of companies and their understanding of solar is shocking, but I can tell you this, five years from now it will not look like that." "Because you might have a guy who has a fair view and even a degree and he has got such a "off the wall" kind of solution that it does not align itself with proper product and long-term installation or he might have the product and the solution, but he has got no service level agreement, so longevity is a problem." [Respondent 9]*

That the market (consumers) and suppliers are not as knowledgeable and experienced as they should be, the respondent concurred with previous comments concerning a lack of technical training in basic education and the tertiary syllabus. As a result the solar industry is going to need to deal with even more challenges: *"I do believe that proper companies in the future will have the responsibility, they will be making a huge investment in training and obviously in South Africa you will find that resources in this industry are a big problem." [Respondent 9]*

On a more positive note, some of the respondents, while acknowledging the lack of technical competence, did liken the development of the knowledge process to that of

the fibre-to-home process experienced in Parkhurst. The comment below indicates that the knowledge gap was similar prior to the roll out of fibre to the home in Parkhurst: "*Look it is technical, but you know what, so is fibre to the home, what did I know about fibre to the home before we got it?" [Respondent 3]*

6.7. Institutions and Infrastructure

In order to understand the changes in consumers' choices and behaviour towards solar technology, it was important to not only understand the consumers, but to look at the state of resources and how they are being managed. The in-depth interviews highlighted many views and much information about the environment in which this technology will either survive or not. The responses that were gathered centred heavily around local and national government, Eskom and policy-making in general within a South African context.

The comment below came from the first interview conducted and the theme within the comment was present in the majority of the respondents' feedback.

"They have to start saying we cannot just look after our friends or try add ANC members, we have got to say who is the best person to run Eskom or who is the best person to do this, because he/she has got this sort of background and experience." [Respondent 6]

One respondent made reference to the fact that society had to supply its own basic services because it felt Government was not doing it properly: *"Ja, and I think politically also, I do not want to rely on anything produced by the government, it is all useless, we have privatised education and health and security and technology, this is just another part of that." [Respondent 6]*

Reference was also made by industry suppliers in that it was up to them to start to govern the industry: *"Maybe the industry will govern itself in the future. I think possibly, if you look at the ABSAs and what they are doing and the standards that they are setting and the appetite they have got, they will eventually start forcing a regulation through the insurance trade as an example." [Respondent 9]*

There was also the sobering view that regardless of how poorly the management of

supply infrastructure or costs is, a positive business case still needs to be present for any one of the above-mentioned stakeholders to actively support the solar energy supply of electricity. This was reiterated by an industry analyst: *"There are a number of factors that is preventing the adoption of this technology and let us try and go through them slowly. The first I want to mention and it is a question of vested interests. So obviously suppliers like the municipalities and Eskom who supply electricity to residential users, do not want to give a tariff that pays people for electricity that they generate, which will ultimately mean them supplying less electricity and they are buying electricity that is not made by themselves, so there is a clear business case issue. They do not want to buy electricity from people who are not themselves, they are in the business of generating electricity and selling electricity for money, so they buy it from residential users they are going to lose revenue on their business." [Respondent 2]*

Contextualising the introduction of solar to the industry from a utility company's point of view was clearly expressed in the following comment: *"In other words, they have done all the investment, and they must keep that whole network working, and only if we go behind the sun they must be there, but it irks Eskom, it really does shake them a little bit, it shakes their foundation..." [Respondent 2]*

The respondent highlighted that the economics or business case needs to make sense holistically and without that, someone will need to subsidise it. Subsidies can come in the form of feed-in tariffs which will either be funded by Eskom, the Department of Energy or consumers themselves, and this was not seen as a viable option by the respondent: *"And I think there are other things the governments want to do with tax revenue, so I do not know if the government is ready to subsidise it, I do not know if the household is ready to subsidise it either." [Respondent 2]*

Due to the financial numbers not making sense in the residential space it was highlighted that there is not much of an appetite for that market and that not much thought or effort is going into the residential market: *"Before you even get feed-in tariffs you need the regulations, the regulatory framework to be in place and I do not think the regulatory framework is concentrating on the domestic level yet." [Respondent 2]*

"They first of all started with the utility level and that, you know, we have the renewable energy IPP program and that is going." [Respondent 2]

The same industry analyst gave credit to South Africa's energy regulator, NERSA, by stating: *"They are in a different league compared to other regulatory authorities in South Africa, I think they stand up, they do the right thing and I think they have got their head screwed on, so I think they just think that actually rooftop solar for households we are not ready for yet, it is not a priority area." [Respondent 2]*

The respondent also highlighted the self-fulfilling concern Eskom faces with poor supply and increasing tariffs and the resultant impact when residents begin to adopt alternative options: *"What it does to them is they sell less electricity, they then have to go to the regulator to say, by the way, our sales are down, our costs are the same we have to put up the price and the regulator has to agree, because as long as it prudently and efficiently incurred extra costs and if the drop in sales is not a result of their own negligence the regulator has no option." [Respondent 2]*

Another local government representative stated that Johannesburg City Power was concerned about the impact solar energy has on electricity revenue: *"No, they are already worried and because who pays the bills, it is suburbs basically and businesses and if they all start reducing usage and City Power really R1.3 billion under recovered in this last financial year." [Respondent 2]*

The challenges facing the energy sector are both structural and operational according to the respondents. Structural challenges are being addressed by the REIPPP process for renewables and by the building of new coal-powered stations. These new stations are being built in response to the growing demand as well as to replace infrastructures that need to be decommissioned due to them being at the end of their lifecycles.

"And slowly, it will take some years for it to come right and it will come right, I am sure, but it will take some time, it does not, these maintenance problems do not get fixed in one weekend of maintenance festival." [Respondent 2]

"That is right, I mean the thing is they are not going to be suddenly one-day running fully. It is going to be a slow progressive, you know, start up, so you know Medupi is expected to be fully on line by the end of 2021, 2020 Khusile by the end of 2025."

"That is the current program and they will come on progressively, but that is okay, it is quite a long way away and if the economy kicks up and demand picks up, you know,

you must just also remember that shortly thereafter there is going to need to be some decommissioning of Eskom generation plants, so that is going to be changing, but then we also, you know, there will be renewable energy with the utility scale coming on." [Respondent 2]

The institutions (Eskom and the Municipalities) that supply power to residents and maintain the distribution resources seem to be battling with the operational challenges that come with running a utility. Some highlights from the interviews indicate this:

"You know, in fact, at City Power, their so-called non-technical losses amounts to 33%. They sell to the city, its residents and industry and 33%, they do not get the payment for." [Respondent 2]

"Basically the city is cutting down on its maintenance, they under-spent on last year's required maintenance budget by R77 million. These bigger substations within the city that are not being maintained properly are the problem and that is why they are popping all the time, it was about a year and half ago that they said it could take 5 years or longer to upgrade all these medium voltage substations." [Respondent 3]

One respondent was certain that competition for Eskom might come in many forms, even forms other than solar energy: *"I do believe that our government will have some kind of green energy alignment, just like all European companies had to do it." [Respondent 5];* and, *"But I think it is going to be extremely slow and then possibly always be behind the curve. I do know that there are going to be companies coming in and challenging, I can already mention some names that have got a plan to become competition to Eskom, European-based companies." [Respondent 9]*

Feedback concerning governance, management and maintenance of policy and infrastructure was not positive. However one respondent pointed out where South Africa is as a country, given its history, and mentioned that its citizens should not criticise too harshly until realising what has been done: *"I think too many people see power costs increase to the extent that they have, to see the supply being less reliable than we had expected it to be and all of that has come as a shock, because we have been very complacent, we have not appreciated how cheap our electricity has been and, frankly, still is, in many respects."*

"What I am saying is the fact that the grid now has to service a significantly expanded

user base; it is unsurprising that it has become somewhat unstable or somewhat unreliable." [Respondent 4]

"Ja, I mean there should have been more forward planning; yes, there should be more rollouts, all of those sorts of thing, but the fact is with what we have got it might perhaps be said that we're doing pretty well, given the expansion and the lack of investments into that infrastructure in the last 20/30 years." [Respondent 4]

6.8. Conclusion

The in-depth interviews collected varying opinions on what influences the adoption of solar PV in South Africa as well as how and when the industry will unfold. Responses were grouped together into external influence categories, such as institutions and infrastructure and the environment, to a more internally-focused influence of access to finance and the level of competence within consumers or potential consumers and the industry suppliers. What was also evident in the in-depth interviews is that solar, in some shape of form, is an integral part of the future energy landscape in South Africa; however, rooftop solar for residential markets may not be the absolute solution that many are hoping for.

7. ANALYSIS OF RESULTS

7.1. Introduction

This chapter aims to draw insights from the results and the literature and identifies key findings in order to answer the research questions proposed in Chapter 3. In this chapter the researcher has taken the themes as discussed by the respondents, and confirmed or questioned the research included in Chapter 2.

7.2. Key findings from the research

7.2.1. Research question 1: What impacts do national factors such as government and institutions have on the adoption of solar technology?

With the current perception, society has of Eskom and Government it was found that these institutions play a big role in the level of adoption of solar technology. Increased mismanagement of infrastructure and funds will speed up the rate of adoption.

From the in-depth interviews, findings showed that people have a somewhat limited view of the influence that the broader macro elements have on the supply of electricity in South Africa. When further examining these national influences one has to be mindful of the country's history and potential legacy-related baggage that comes with it.

When asked about the state of electricity the respondents were negative and felt that due to legacy issues, lack of appropriate leadership and the inability to execute properly, South Africa's energy supply was not at the standard that it should be. Some respondents looked to blame it on cronyism within ruling parties and others just stated outright that they do not rely on anything produced by the government, citing other examples such as education, health care and security that have had to be supplied by private entities and now electricity is seen to be going the same way.

These sentiments can be alarming if one looks to literature on citizens' satisfaction that influences their perceptions and behaviour. This research states that the effectiveness

of the delivery of public services is measured by its ability to satisfy citizens' needs, wants and expectations. However, satisfaction levels often reflect the quality of life perceptions and the degree to which citizens trust their government (Gofen, 2012).

With this low level of satisfaction and trust, the majority of the respondents felt that solar energy is a key player in the electricity-supply future of South Africa and mentioned the low levels of trust and service as well as intermittent supply, are motivators for adoption.

The integrated acceptance and sustainability assessment model (IASAM) cites management as one of the four main influencers of technology diffusion, especially on a large scale such as solar energy adoption for a country (Aizstrauta et al., 2015). If cronyism is being raised as an issue, then the perceived level of political and legislative support from Government is not at very high levels, which can speed up the move towards exiting the national grid.

7.2.1.1. Intermittent supply

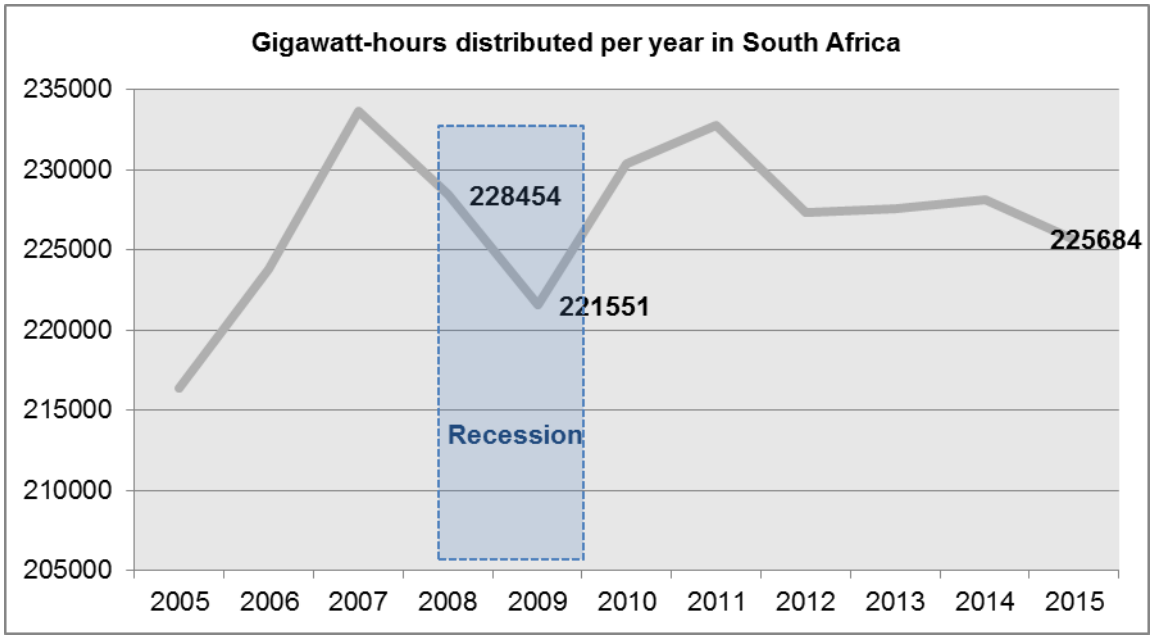
Intermittent electricity supply could be seen as part of the cause for a 0.7% economic growth in the third quarter of 2015 (StatsSA, 2015b); alternatively, one could look at the poor economic growth and see it as a blessing for the suppliers of electricity in that the actual requirement has been below the available capacity, masking the supply crisis Eskom finds itself in.

While the electricity supply issue is not the sole cause of poor GDP growth, it plays its part. The felicitations that Eskom is receiving recently about the decline in load shedding may be premature and credited to the wrong party; there are more structural issues at play and in addition to the funding deficit and consequently rising electricity tariffs, Eskom is also grappling with a significant maintenance backlog (Sikonathi & Charlotte 2015).

Feedback from the interviews seemed to support the fact that the poor GDP performance is making Eskom look good and not the other way around. The respondents highlighted that demand has reduced, mainly driven by two forces, namely load shedding has forced consumers to attend to their demand requirements and has forced them to look at alternative ways of sourcing power, and the second is the

stagnant economic growth, which inherently curbs demand (Vuuren, 2015).

Figure 7.1 – Electricity demand in South Africa: 2005 - 2015



Source: (StatsSA, 2015a)

Axis Details:

X Axis – Years

Y Axis – Grey Trend line indicates total gigawatt hours distributed

What was noted by energy experts and has also been communicated publically is that load shedding is a two to three-year reality from 2015 – 2018; however the load shedding plans communicated by the utility companies to consumers are inaccurate and make it difficult for consumers to plan around the outages.

Responses worth noting from the survey and interviews was that 50% of residents and business owners reported to be affected by load shedding at least once a week but only 27% claimed to suffer any financial loss because of it. While the actual measurable loss may not be that sizeable, and this is in the context of the Parkhurst area, it is the inconvenience and sense of unknowing that load shedding brings; and it is this lack of delivery that exacerbates consumers' feelings of being unsatisfied. This lack of satisfaction unsettles the status quo - consumers start to search for alternatives and become more susceptible to adopting alternatives, however the appetite to adoption, as seen in the current electricity situation in South Africa, ebbs and flows, a behaviour confirmed by Gofen (2012) who states that the notion of satisfaction is fluid.

In summary, the supply issue has an influence on the adoption however it is not a very strong one, as people tend to find alternative ways fairly easily. The potential poor supply, as highlighted above, has also been supported by lower than ideal growth figures.

7.2.1.2. Lack of maintenance, therefore increasing costs

Probing further during the interviews resulted in those respondents with a formal knowledge of the maintenance situation sharing some information, namely that in addition to the decision not to invest in new capacity when it was required, the maintenance and upkeep of the current infrastructure was also poor.

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Through staff reduction and the use of contractors, the level of technical competence is lacking and the level of investment in maintenance by Johannesburg City as an example is R77 million behind where it should be. The financial impact is compounded by the fact that the same institution (Johannesburg City) under-recovered 33% of its revenue, which amounted to R1.3bn. The level of poor management is not widely known by consumers and it seems that unless drastic faults of considerable size occur, the fluidity of satisfaction is evident and consumers tend to fall back into a false sense of comfort with the current state of electricity supply (Gofen, 2012). This reduces the level of interest in solar and therefore the adoption levels.

Increasing costs are going to play a big role in consumers' perception of Government and Eskom and things other than just electricity costs will exacerbate this. Increasing costs due to poor management will certainly increase the adoption levels of solar technology.

7.2.1.3. Unwillingness to allow feeding in – business case, lack of appetite due to lost revenue

The largest single influencing factor for all parties looking to embark on renewable energy is the financial viability. If you are a large utility company, your willingness to supply electricity is driven by the price consumers pay over the cost at which you can produce it. For a consumer the decision is influenced by his/her ability to fund the solution but more importantly, it is the attractiveness of the business case.

Respondents made many comparisons to countries such as the USA, England and other European countries regarding their adoption levels of solar and one needs to remember that the price-supplied electricity in South Africa is still relatively cheap compared to the above-mentioned countries.

Power utility companies or Government would need to incentivise consumers to adopt solar and the best way to do this is through a feed-in tariffs (FIT) scheme. A FIT scheme would see renewable energy producers receiving a set rate or fee for energy that is produced through a renewable source, such as residents producing excess energy through roof top solar systems. A FIT scheme is the most effective policy structure to promote and sustain renewable energy adoption (Muhammad-Sukki et al., 2014).

It is against this backdrop that the researcher questions the appetite for renewable energy as a source of mainstream supply in South Africa currently, especially because Eskom has already committed R330 billion to the building of two large coal-powered plants. However, the project is yet to be completed, which will result in that amount increasing exponentially as delays are experienced.

The increasing costs have to be recovered and it is mainly through tariffs whereby Eskom will look to do so, further increasing the cost of electricity from a fossil fuel source and enhancing the attractiveness of alternatives. Yet, committing to a large scale decentralised renewable energy generation such as residential rooftop solar, may deem some of this planned coal-powered capacity redundant; this is a contributing factor to the absence of feed-in tariffs as FIT increase the adoption rate of solar remarkably (Muhammad-Sukki et al., 2014).

Another contributor to the lack of FIT is the potential loss of revenue that Eskom and government-run municipalities will experience and, as identified during the interviews, 40% of this revenue goes towards funding non-electricity-related costs, a sizeable contribution that the municipalities will not want to forego.

The level of path dependency established through the literature, coupled with the revenue dependency on electricity, are two strong driving forces behind the lack of feed-in tariffs, despite their recorded positive influence on solar energy adoption.

7.2.1.4. Financial institutions lack of financing options

The drop in reliability and lack of supply where needed has created a pseudo gap in the market in which alternative energy sources should take some share now and into the future, regardless of Eskom's recovery. However, there will need to be some form of funding mechanism, as very few consumers are able to self-fund solar systems.

Financial institutions have highlighted that renewable energy and solar technology is very topical, however none of them have built innovative financing options for the residential consumer to take advantage of this technology in order to make the switch from fossil fuel-driven energy to solar driven energy. The financial institutions have seen a lacklustre adoption of solar technology and are therefore talking about readiness but are not actively building lending mechanisms specifically designed for solar solutions. There seems to be a chicken and egg scenario whereby the financial institutions are waiting to see the demand before aggressively pursuing the market. A study of CEOs on the topic of sustainability showed that 93% of them viewed sustainability as a critical issue for the future of their businesses (Larossi et al., 2013). The researcher hopes that this perception is met with the same conviction when it comes to building accessible financing options because comments from the respondents interviewed highlighted the fact that the presence of financing options would increase their ability and willingness to adopt solar solutions.

This stagnant state is driven by two elements, namely the cost of fossil fuel- driven energy is still available too cheaply and the cost of borrowing for the consumer is still too high. Financial institutions conversely are not going to lend money at rates below their required cost of capital, as it does not make financial sense.

7.2.2. Research Question 2: To what extent does the community/society that people reside in, affect the adoption of solar technologies and/or energy-efficient technologies/strategies?

7.2.2.1. Speed of adoption increases

While it was noted in the data collection and analysis that community/society plays a large role in the adoption rate, it was further determined by the researcher that this role will be more of an informative role that helps to educate community members on the

benefits of solar technology. The decision and commitment to adopt solar technology is a large one and an expensive decision, which even with reference groups and the community displaying positive and successful implementation, there has still been hesitation due to the financial element. This is seen in the summarised results below.

Drawing from the literature one can confirm that adoption of innovation is positively or negatively influenced by the level of trialability. It is also noted that an additional attribute that speeds up the adoption of a technology is social approval (Kapoor et al., 2014).

In the case of this research, respondents agreed that the influence of social groups and reference groups was key to both the speed and penetration of adoption of a new technology. An example was the fibre-to-home initiative adopted and driven by the residents' association - the impact of which was a diffusion that took less than a year in Parkhurst versus what could have taken three years.

These social groups play an important role in building social sustainability. McKenzie (2004) defines social sustainability as "a life-enhancing condition within communities, and a process within communities that can achieve that condition". Social sustainability is the least expressed and understood element of sustainability. However for societies to move towards a more sustainable environment, people are reliant not only on their knowledge of ecosystems and resources, but on their ability to initiate, advocate and absorb lifestyles, values and technology (McKenzie, 2004). McKenzie (2004) identifies a few important aspects of this life-enhancing process. These include the importance for individuals to enjoy equitable access to key services such as energy housing, education, transport and healthcare. There also needs to be a system to transmit awareness of social responsibilities from one generation to the next, and with a technology that has so much to offer, it was important for the researcher to understand what drives society to adopt solar technology.

The intangible attribute of trust to mitigate the level of perceived risk has a considerable influence on adoption - when people observe technology working in the lives of others, they look for advice and reassurance that the particular risk of loss or failure will be mitigated, which in turn will reduce the hesitation against solar energy adoption.

With specific focus on solar energy solutions, 80% of the 102 respondents to the

survey claimed that they would adopt the technology after observing it through friends or social groups.

7.2.2.2. Learning from community

Adoption of technology is also dependent on the level of complexity and ease of use (Kapoor et al., 2014); one respondent noted during an interview that consumers' knowledge is being developed through communal interaction on platforms such as the "I love Parkhurst" page on Facebook. Where initially residents were discussing candles and torches as their mitigation to power outages, they now discuss options for inverters and battery technology, simply by learning through exposure. Further support for the impact of communities on adoption of technology specifically is housed in the literature of early adopters. This is in the form of collective, self-built user communities supported by social media such as the "I love Parkhurst" page, to enable the sharing of information, experiences and expertise, and evidence shows that these communities significantly stimulate diffusion of technology (Nygrén et al., 2015). Therefore, these types of forums and interactions should be promoted because when communities and social conversation around solar energy occur, the adoption of solar technology is significantly improved.

7.2.3. Research Question 3: How do individuals' personal beliefs and aspirations influence the adoption of solar technology?

7.2.3.1. Environmentally friendly view

In the literature about the ecological impact of society, it was noted that increasing awareness of the true costs of human economic activity on the planet means that people are becoming attuned to the notions of "reducing ecological footprints" and "living sustainably". As such, these values are playing a key role in decision-making processes when it comes to product, brand or technology selection (Chen, 2014).

The statement above still seems a little ideological when consolidating the interview feedback in which respondents of the survey who had adopted solar technology rated the environment as their second motivator of adoption, behind cost saving. This is consistent with findings in the interviews that doing "good" for the environment is an afterthought and an added bonus of adopting renewable energy alternatives. It is very

difficult to motivate consumers to adopt solar technology based on the environmental lever in isolation; the fact that your choice is benefitting the environment is more of a post-adoption reassurance.

This is besides the fact that Edenhofer et al. (2011) state that the adoption of energy-efficiency measures, technologies and renewable energies, for example, is often done within the context of the need to reduce greenhouse gas emissions and combat the effects of climate change.

Looking ahead however, in some of the literature a slightly more optimistic view was taken in that it claimed 93% of CEOs in a study viewed environmental consideration a must in the future business strategy (Larossi et al., 2013). Hopefully this mentality will filter into South African citizens' everyday life.

Concerning personal aspiration or belief in doing good for the environment, there was not a strong relationship between that and adoption of solar. The positive influence alternative energy sources have on the environment was a very distant motivation for adoption. This factor was not a big influencer and as stated by a respondent, it is more of an afterthought.

7.2.4. Research Question 4: What are the personal circumstances that motivate or discourage the adoption of renewable energy technology such as solar?

7.2.4.1. Cost of solution

As discussed earlier, the cost of solar solutions for suppliers and consumers of electricity is the biggest single factor influencing the adoption rate. This can be seen in the results of the survey in which the highest-rated reason for non-adoption was "cost too high", rated at 3.9 out of 5. Only nine out of the 102 respondents had adopted some form of solar PV technology for electricity replacement, which equated to a low 8.8%.

Electricity is a basic human requirement, which makes the discussion on the cost of solar technology a relative one, relative to the cost of electricity from either Eskom directly or a municipality. While the cost of fossil fuel electricity remains relatively cheaper than solar electricity, consumers will view solar energy as too expensive. The

abovementioned perceptions, and therefore the rate of adoption, are influenced by the tariff increases that consumers are going to endure. Consumers will always require power and will continue to source it from the most affordable supplier.

7.2.4.2. Access to funding/finance – Feed in tariffs

A form of bridging between affordability and adoption is the presence of financial tools to allow consumers access to funding to acquire equipment to produce solar energy. Consumers are more susceptible to adoption when there is less of a capital outlay. This is illustrated in the USA where close on 90% of all residential solar solutions are sold through lease or power purchasing agreement (PPA), a far more advanced solar market than South Africa.

South African residential consumers do not have attractive or affordable enough financial mechanisms to improve the adoption levels. Financial institutions continue to assess this type of technology as a luxury and treat it as normal asset finance, which does not promote the adoption but actually makes it more unaffordable. A key finding from the interviews was that building leasing options or power purchase agreements would be the way of the future and how the majority of solar energy solutions would be installed. The financial viability of this will only come to fruition after a couple more electricity tariff increases, which will occur over the next 12 – 18 months for commercial applications only. This is only if the South African market develops on the same path and trajectory that the US solar market did, which is not guaranteed.

7.2.4.3. Debt levels

While the inconvenience and in some cases financial loss (27% of the survey respondents), are an issue, it is also important to consider the general level of indebtedness South African's find themselves in, and what other necessities they are willing to forego in order to ensure supply of electricity. One respondent grouped budget items such as rent and school fees into the competing category to electricity.

7.2.4.4. Complexity of solution and technical competence

Nygrén et al. (2015) cite the fact that technology adoption takes too much effort on a personal level and therefore we see a slower rate of adoption in many cases. This was

evident in the findings of the interviews and survey in which respondents claimed that solar technology was still very much an unknown to them and their level of understanding was poor. This is exacerbated by the lack of clarity displayed by the solar practitioners themselves who quipped, "*Our biggest joke in our industry is that 90% of our clients do not understand our quotations."*

Also noted by Crosno and Cui (2014), a supplier value chain has a large part to play in the breaking down of certain barriers, giving consumers peace of mind about an often misunderstood technology. In order to improve the trust and adoption of solar technology, the industry will need to start simplifying their offerings and educating consumers on the technical make-up and overall benefits of solar technology. This is a responsibility that solar practitioners claim sits on their shoulders.

7.2.5. Research Question 5: To what extent are middle class/upper income households electing to remain 'on-grid'?

7.2.5.1. Base load discussion

During the interviews, it was noted that a certain base load of electricity is required by the South African public and that solar fell into an intermittent or mid-merit scheme. Other sources such as coal or nuclear energy fell into a base load scheme. The distinction is better understood by analysing what energy can be produced only when the sun is available (intermittent) and what is required all day long (base load). In order to get solar to a point where both non-sunlight and sunlight hours are covered, consumers require storage capacity in the form of batteries. This inclusion of batteries is very expensive (about 60% of total solution cost) and at current costs it makes removing oneself from the grid non-viable.

Figure 7.2 – Eskom costs versus solar alternatives

Type of system	Cost	Energy supplied by solar	Shortfall
Grid tie	R 89,144.00	7.82	7.86
Multi-hybrid (panels & Batteries)	R 160,578.00	11.93	3.75
Island (No Grid)	R 295,249.00	15.68	0

Consumption per day	Tariff increase per year	Current Eskom Tariff
15.68	8%	1.4

Eskom Tarriff	Year	Consumption per year - Kwh	Eskom cost per year	R/KwH	Grid	R/KwH	Multi	R/KwH	Island
R 1.40	2016	5723.2	R 8,012.48	***R 1.70***	R 9,701.66	***R 2.12***	R 12,157.19	***R 3.29***	R 18,829.66
R 1.51	2017	5723.2	R 8,653.48	***R 1.75***	R 10,022.98	***R 2.15***	R 12,310.49	***R 3.29***	R 18,829.66
R 1.63	2018	5723.2	R 9,345.76	***R 1.81***	R 10,370.00	***R 2.18***	R 12,476.06	***R 3.29***	R 18,829.66
R 1.76	2019	5723.2	R 10,093.42	***R 1.88***	R 10,744.79	***R 2.21***	R 12,654.87	***R 3.29***	R 18,829.66
R 1.90	2020	5723.2	R 10,900.89	***R 1.95***	R 11,149.55	***R 2.24***	R 12,847.98	***R 3.29***	R 18,829.66
R 2.06	2021	5723.2	R 11,772.96	***R 2.02***	R 11,586.70	***R 2.28***	R 13,056.54	***R 3.29***	R 18,829.66
R 2.22	2022	5723.2	R 12,714.80	***R 2.11***	R 12,058.82	***R 2.32***	R 13,281.79	***R 3.29***	R 18,829.66
R 2.40	2023	5723.2	R 13,731.98	***R 2.20***	R 12,568.71	***R 2.36***	R 13,525.06	***R 3.29***	R 18,829.66
R 2.59	2024	5723.2	R 14,830.54	***R 2.29***	R 13,119.39	***R 2.41***	R 13,787.79	***R 3.29***	R 18,829.66
R 2.80	2025	5723.2	R 16,016.98	***R 2.40***	R 13,714.13	***R 2.46***	R 14,071.54	***R 3.29***	R 18,829.66
R 3.02	2026	5723.2	R 17,298.34	***R 2.51***	R 14,356.44	***R 2.51***	R 14,377.98	***R 3.29***	R 18,829.66
R 3.26	2027	5723.2	R 18,682.21	***R 2.63***	R 15,050.14	***R 2.57***	R 14,708.95	***R 3.29***	R 18,829.66
R 3.53	2028	5723.2	R 20,176.79	***R 2.76***	R 15,799.33	***R 2.63***	R 15,066.39	***R 3.29***	R 18,829.66

The table above has been calculated on quotes obtained from a solar practitioner for various configurations of solar systems. The daily consumption requirements were based on a medium-sized household with a family of four. The daily consumption remained unchanged, only the configuration altered.

Findings from the assessment are that there are three different configurations of solar systems in the comparison, namely:

Grid tie - Includes a panel array and components but not storage capacity.

Multi-Hybrid - Includes both a panel array and batteries however not all the daily energy requirement is supplied by the batteries; 23% must be supplied by Eskom.
Island system - Is a system that is autonomous of Eskom and has no grid connection.

Highlighted in yellow in Table 6.1 are breakeven points of different types of solar systems against Eskom, given a very conservative 8% annual escalation. One can see that being independent of the grid by implementing an Island system is not viable and requires a consumer to wait 13 years before Eskom is a more expensive option, within which time the system requires more investment. A combination of solar panels and batteries in the form of a Multi-Hybrid breaks even in year eight, whereas a Grid tie system offers no battery power, and breaks even within six years, however your non-sunlight energy needs to be supplied by Eskom.

Solar system costs that include battery storage are currently 1.5 times greater than what Eskom supplies at and with systems in which a consumer may require total autonomy from Eskom, his/her per-unit cost is 2.4x more than what Eskom supplies at.

Consumers, as highlighted earlier, have a limited understanding of their energy requirements and how solar technology can satisfy these. They also have very little comprehension of the cost. Of the 102 respondents, 82 (80%), indicated that they were highly likely to adopt solar once they had seen it work in their community; however this enthusiasm may be challenged if they were to fully understand the financial calculations in more detail.

Personal circumstances and financial costs were the largest influencing factor of adoption in both the quantitative and qualitative feedback, followed by the lack of understanding of the technology. South African residents have not adopted solar technology in any considerable form. There is not enough of an impetus and the lack of access to funding seems to be motivating this.

8. CONCLUSION

"Today, in directly harnessing the power of the Sun, we are taking the energy that God gave us, the most renewable energy that we will ever see, and using it to replace our dwindling supplies of fossil fuels." – President Jimmy Carter 20 June 1979. The president of the USA was speaking at the ceremony marking the installation of solar hot water panels on the roof of the White House (Hoffman, 2014). At the time, a detailed study was undertaken on the adoption of solar energy in the USA. This study revealed that solar has positive environmental effects and enables a reduced dependence on costly fossil fuel products. However, it was also noted that there was limited public awareness of and confidence in, solar technology; State policies and market imperfections subsidise fossil fuels and financial barriers limit adoption. Many of these factors mentioned in 1979 are still inhibiting the adoption of solar technology in South Africa today. This research study set out to try to understand what factors are influencing the adoption of solar power in the residential market.

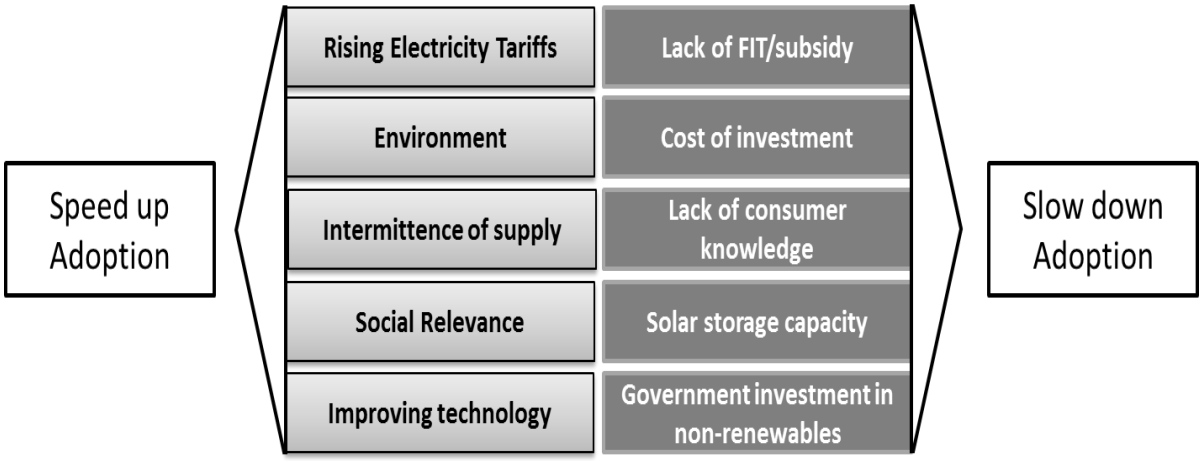
8.1. Key Findings

The research has illustrated that opposing forces driving the case for decentralised solar adoption and centralised utility-based electricity supply are present.

The findings of the research also highlighted society's inability to act, given a gradual degradation in place, rather than a drastic one. In more than one interview the respondents expressed their view that South African's require a dramatic shock to the system in order to invoke change otherwise they will suffer eventual and undesirable results, due to a creeping normality often explained by the "boiling frog syndrome". South Africans need more dramatic and immediate forces to initiate change.

The forces most at play are economics and information. They are best illustrated in the trade off model in Figure 8.1.

Figure 8.1. Fossil fuel electricity is still too cheap



Economies of scale is a term that is used to describe a process whereby increasing output the average cost per unit is decreased (Bernet & Singh, 2015). It is through this approach that fossil fuel- produced electricity is compared to that of renewable sources of electricity for residential properties in South Africa; the vastly developed infrastructure of Eskom is able to consistently beat the cost of a Kwh from coal versus what solar technology can do. The combination of rand per kilowatt - R/Kwh and the level of supply from fossil fuel energy needs to be equal or more than that of solar in order for people to switch and currently it is not. Just the financial cost alone is 1.5 times more than that of Eskom. There are also the vested interests of municipalities and Eskom (and thus, the State): they keep people on the grid in order to generate a revenue stream for the abovementioned entities so that they can continue to cross-subsidise utilities; they keep State-owned enterprise and public employment levels high; and they benefit from tenders. As a result, there are no feed-in tariffs; no subsidisation of solar installations; Eskom has dropped its demand-side management campaigns; no tax rebates; and no pressure on the banks to provide finance.

This does not mean that solar energy will not gain acceptance. There are high levels of supply concern and a growing frustration amongst consumers who believe the supply of electricity, or the lack thereof, in the current situation is not only an inconvenience to themselves, but is damaging the economic opportunities of South Africa. However, when doing the financial calculations on payback, excluding the financing costs, periods of eight to twelve years is not an attractive proposition. This will however be

changing in the near future as rising electricity tariffs – and these are set to rise substantially in the future - the industry is experiencing a reduction in the cost of solar technology, making it more and more affordable.

Situated in the same motivational category as cost and affordability of solar is the presence, or lack thereof, of financial vehicles to make solar technology more accessible to consumers. People lack the cash flow to commit to a high monthly outlay, even with the associated cost savings on their energy bill. This is partly due to other budget constraints, for example school fees.

Financial institutions in South Africa take a very conservative outlook on financing improvements or products such as these. Reasons identified are: a) the National Credit Act applies strict criteria to lending; b) the financial institutions themselves are highly conservative and only want to lend on the building itself and then limit money for home upgrades which need to be second bonds if necessary; c) interest rates are high and this adds to the cost of financing solar technology improvements significantly; d) banks have not yet set up the kinds of relationships they have with plumbers, electricians regarding insurance claims and the like and so they don't trust the solar installers and there is not a package deal on the table for homeowners to consider. The fact that no technology-specific financing options are available to South African consumers and that this void is a key contributor to the slow adoption rate was evident in the responses.

The lag in infrastructure development and lack of maintenance will exponentially increase tariffs at which the national utility is able to supply electricity. In all of the literature and responses from interviews, it was noted that cheap electricity for South Africans is a luxury of the past and price parity is less than two years away.

Findings in the research suggest that the State and Eskom do not have the capacity to manage resources, are not making the correct strategic decisions and have too much at stake in seeing fossil fuel-supplied energy continue. Municipalities have under-recovered 33% of their revenue from consumers and it was also noted that 40% of the revenue that comes from electricity subsidises other areas of their budget, so pushing an energy supply model that takes the control of power literally and figuratively out of their hands, is something that has not truly garnered political support.

The final main category of findings is that which focuses on society, social media and the power of developing consumer knowledge from other citizens. South African consumers have very little knowledge of solar technology, what their requirements are, and how to go about acquiring and implementing it; and that this knowledge is critical for reducing trepidation and the “unknowns” around the technology. Reduction of these unknowns reduces the perceived risk thereby improving adoption rates.

The ability to contribute to a topic such as solar energy develops the level of loyalty one has for- that particular topic. Because social platforms such as Facebook are being used more and more as a consumer feedback tool, loyal members are getting more share of voice and this has allowed institutions and citizens to learn (Gerken, 2013Gerken, 2013).

Responsibility for developing this industry proactively lies on the industry players shoulders. This development is not without its own challenges and the solar practitioners themselves:

- a) don’t know how to market their product effectively;
- b) don’t realise that they have to speak less “tech” and focus on ‘teaching’ their potential clients about the product and how it works, this requires staff with soft skills;
- c) have an image that has been tarnished by fly-by-night installers who don’t know the products they are selling and therefore sell sub-standard products, don’t provide after sales service; and
- d) overcharge and often go out of business.

Solar practitioners have not focused on building their brands, which contributes to building trust and building a relationship with the targeted community. They need to be innovative and find ways of

- bringing down the price of their product;
- getting finance packages together – perhaps even leasing; and
- realising they are selling a service not a product and so should focus on maintenance and troubleshooting aspects of the product as well because clients need peace of mind, especially with a technology as misunderstood as solar.

What was encouraging to see is that technical competence displayed in the studied community improved due to cross-sharing of experience and knowledge and the simplicity of a solar proposition from solar practitioners is critical going forward.

8.2. Research limitations

This research set out to understand the factors influencing the adoption of solar energy technology in households. In order to do this a mixed-method approach was chosen, whereby a survey was created and distributed through an online social media platform and completed by consumers. The second approach was in-depth interviews conducted with energy industry experts.

The nature of the topic and approach to research created some inherent limitations:

- The survey sample was a non-random sample, which was isolated to a certain lifestyle and stage. It is not advisable to use the findings as a representation for the entire population.
- The sample size was small and only represented just over 1% of the potential group's population.
- During the interview, respondents were asked to answer in their professional capacity; however, the nature of the topic meant that they might have responded in both a professional and personal capacity.

8.3. Recommendations

South Africa is one of the global hotspots for the solar industry, given the high levels of solar irradiation and the social requirements of a developing nation, yet the level of solar adoption is exceptionally low and even countries such as the United Kingdom boasts five times the amount of solar energy production when compared to South Africa. This research was limited to and focused on adoption drivers in the residential market; however, through the process larger macro and micro influences have been identified which would require further research.

These are as follows:

8.3.1. Outlook for centralised infrastructure

Regardless of the urbanisation occurring within South Africa and by implication creating more centralised communities, the solar energy industry will cause a phenomenon of a

decentralised power supply. As more people adopt solar technology, the requirement on the national grid will diminish, which means the revenue base of Eskom and the municipalities will reduce. However, some of the costs will decline as well, such as maintenance and management of the distribution of power. It would be interesting to understand the financial impact of this shift and the resultant implications for the current electricity supplier. There is also a social impact in that electricity revenue collected from paying consumers is used to supply a minimum base level of electricity to less fortunate residents of South Africa. With less money coming in, the state will need to adapt the source of income and potentially generate this revenue through taxes; a study should be done to understand this timeline.

8.3.2. Cost comparison between two technologies

Although respondents in this research made predictions of where the cross-over point is between the cost of electricity produced by fossil and solar, it would be beneficial to understand the exact point in time when independently-generated solar electricity becomes more cost-effective than electricity supplied by the national utility company, Eskom. Power utility companies or Government would need to incentivise consumers to adopt solar and the best way to do this is through a feed-in tariffs (FIT) scheme. A FIT scheme would see renewable energy producers receiving a set rate or fee for energy that is produced through a renewable source, such as residents producing excess energy through roof-top solar systems. Eskom's coal-powered source of supply is diminished and is being replaced by expensive diesel-run generators, so there is no reason why FIT should not be allowed to mitigate the diesel cost.

8.3.3. Skills development and manufacturing competencies

South Africa is a consumption-driven economy and like many other countries, lacks the efficiency and competence to compete with industrial powerhouses such as China. Further research is required to understand the production capabilities that are required in South Africa in order to make the country a manufacturing leader in solar energy technology. For solar energy to benefit the economy, South Africa must become a net exporter of equipment and skills in the solar industry through efficiency and innovation. A study to understand what this would take should be done.

8.3.4. Funding

Lastly, there is a need for innovative and inexpensive funding structures for the adoption of solar technology in South Africa. No clear attractive funding mechanism was identified during this research but it was noted that a mutually- beneficial funding mechanism would unlock this industry and exponentially improve the adoption levels in residential households. A study should be done on designing and co-developing mechanisms that would allow the South African consumer to own the supply and generation of their electricity needs while also positively contributing to a healthier environment.

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APPENDICES

Appendix I: Initial Cover Letter

RE: MBA Research project – Factors influencing the adoption of alternative energy (e.g. solar technology) in South Africa

Dear Mr./Ms. Participant,

I am conducting some research for my MBA though the Gordon Institute of Business Science, University of Pretoria. The research involves understanding the factors influencing the adoption of solar technology in South African households. Through interviewing a number of people across residential suburbs, I hope to better understand factors hindering and contributing to alternative energy adoption.

Confidentiality will be observed throughout the research process and the final report will be for academic purposes only. Your participation is voluntary and you can withdraw at any time without penalty. The duration of the interview will be no longer than an hour. I would be most grateful for your participation. Please confirm if you will be willing to assist. If you have any concerns, please contact me or my supervisor. Our details are provided below.

Donavan Hendricks
donavanhendricks@gmail.com

Tracey McKay
mckaytjm@unisa.ac.za

Appendix II: Informed Consent Letter

Dear Participant

FACTORS INFLUENCING THE ADOPTION OF PHOTOVOLTAIC TECHNOLOGY AS AN ALTERNATIVE ENERGY SUPPLY IN HOUSEHOLDS

My name is Donavan Hendricks. I am an MBA student at the Gordon Institute of Business Science under the supervision of Mrs T. M. McKay.

Introduction

This study seeks to examine factors that influence the adoption of solar technology in households

Invitation to participate

This is an invitation to you to participate in the study.

What is involved in the study?

Your involvement in the study would be that of being a participant in a questionnaire. The process will not be a long one and should take a maximum time of 30 minutes.

Risks

While nothing in life is risk free, there are, for all intents and purposes, no risks involved in participation.

Participation is voluntary

The refusal to participate will have no penalty or loss of benefits to which the participant is otherwise entitled, and that the participant may discontinue participation at any time without penalty loss of benefits to which they are otherwise entitled.

Confidentiality

All personal information will be kept confidential and there will be no personal ramifications of any results found. Results will be captured in a manner that will ensure confidentiality.

Contact details of researcher

For further information you can contact me on: 076 429 4653.

Or the supervisor Ms T. M. McKay on 073 264 9496 or mckaytjm@unisa.ac.za

Signature: ..... Date: .....

Appendix III: Written consent for social media questionnaire distribution

Attention: Gordon Institute of Business Science (GIBS) Ethics Committee

My name is Cheryl Labuschagne and I am the Chairperson of the Parkhurst Residents' and Business Owners' Association (PRABOA).

I am aware of the request put forward by Donavan Hendricks, MBA student (11367972) at GIBS to distribute an online survey aimed at the members of PRABOA as part of his study: ***Factors influencing the adoption of photovoltaic technology as an alternative energy supply in households.***

I hereby give formal consent for him to do so.

Further, I request access to the results of the research once completed.

Regards
Cheryl Labuschagne
Chairperson – PRABOA

Appendix IV: Interview Guideline for In-Depth Interviews

Introduction and Background Information

- Welcome
- Discuss confidentiality regarding the data
- Obtain signature in the consent form
- Introduce the title of research

Discussion on Literature

From the literature review, broadly explain following concepts:

- Service Delivery
- Community impact and behaviour
- Adoption of technology

Discussion of Objective

The aim of this research project was to explore what steps households of a middle class/upper income suburb, located in Johannesburg, have taken to reduce their utility bills and their reliance on the electricity grid as well as identify factors that are influencing the adoption levels in South Africa.

Questioning approach

By using a Critical incident technique ask respondent to describe their experience with solar energy in South Africa and their opinion on the factors influencing adoption.

In conclusion

- Reflect on the interaction and discussion, identify any missed opportunities and ask for clarity.
- Final comments and thank participants

Gordon Institute of Business Science
University of Pretoria

Dear Donavan Hendricks

Protocol Number: **Temp2015-02192**

Title: **FACTORS INFLUENCING THE ADOPTION OF PHOTOVOLTAIC TECHNOLOGY AS AN ALTERNATIVE ENERGY SUPPLY IN HOUSEHOLDS**

Please be advised that your application for Ethical Clearance has been APPROVED.

You are therefore allowed to continue collecting your data.

We wish you everything of the best for the rest of the project.

Kind Regards,

Adele Bekker