THE POTENTIAL FOR SOLAR WATER HEATERS IN URBAN DEVELOPMENT IN KWAZULU-NATAL

Tobisa Dlepu

Submitted in fulfillment of the requirements for the degree of

MASTER OF ARTS

In the Faculty of Business and Economic Sciences

at the

NELSON MANDELA METRO METROPOLITAN UNIVERSITY

DECEMBER 2014

Supervisor: Pavel Parks

ACKNOWLEDGEMNTS

My very special thanks to my mother, the late Judith Nomajuda Eslina Dlepu for instilling in me sound values to persevere no matter what the circumstances are.

I acknowledge my indebtedness to my daughter Ongezwa, my sister Thandokazi, my brother Mthobi and the rest of the family and friends for their unfailing support, encouragement and assistance during the course of the study.

I would like to express my profound gratitude and appreciation to my substantive research supervisor Mr Pavel Parks for his academic leadership, patience, personal motivation, who despite his busy schedule was able to guide me through this research until the final write up.

I greatly appreciate the contribution made by all participants (Buffer Strip Residents) interviewed during the survey in the households using solar water heaters.

Finally, and most significantly, I acknowledge the providence, grace and peace stemming from the God Almighty.

DECLARATION

DEPARTMENT OF ACADEMIC ADMINISTRATION
EXAMINATION SECTION
SUMMERSTARND NORTH CAMPUS
PO Box 77000
Nelson Mandela Metropolitan University
Port Elizabeth
6013

Enquiries: Postgraduate Examination Officer

Nelson Mandela Metropolitan University

for tomorrow

DECLARATION BY CANDIDATE

NAME: NOMSA NCAMANI

STUDENT NUMBER: 213400693

QUALIFICATION: MASTER IN PUBLIC ADMINISTRATION

TITLE OF PROJECT: AN ASSESSMENT OF THE RECORDS MANAGEMENT SYSTEM WITH REFERENCE TO THE AMATHOLE DISTRICT MUNICIPALITY

DECLARATION:

In accordance with Rule G4.6.3, I hereby declare that the above-mentioned treatise/ dissertation/ thesis is my own work and that it has not previously been submitted for assessment to another University or for another qualification.

SIGNATURE: N Ncamani

DATE: 17 MARCH 2015

TABLE OF CONTENTS PAGE

LIST OF FIGURES AND TABLES

Annexure A (Bar graphs)

Annexure B (Pie Charts)

LIST OF TABLES

Annexure C

1. SUMMARY

The study found that investing in solar water heater system (SWH) would be an economically, socially and environmentally viable option to implement within urban households; in which the hot water demand, volume of hot water consumption, water heating costs, and electricity tariffs are high. Investing in solar water heater technology should be the key focus of South African government; in order to enhance the wellbeing of the ordinary citizens. The study made use of the qualitative research approach to investigate solar water heater drivers and barriers; from the perspective of energy consumers. This will be achieved by focusing on the major drivers and barriers that consumers consider when making decisions on adoption of solar water heater system. It is believed that solar water heater drivers and barriers substantially influence the potential and urban development thereof. Solar heat is utilized in the residential sector for heating water for bathing, cleaning, washing and cooking food, but its availability is limited (Arora & Arora, 2013). Renewable energy has become a wild card internationally and regionally because of the technical, economic and environmental barriers affecting the disadvantaged individuals.

2. INTRODUCTION AND CONTEXT

The research aims to investigate the potential for solar water heating (SWH) technology in urban development. Urban development is a major socioeconomic structural change driven by rapid urbanization which leads to urban growth. Urban areas of developing countries absorbed about 600 million people between 1950 and 1980. Revealing the impact of SWHs in the South African residential urban sector; opportunities and barriers; outlining the effect of absorbing SWHs; energy demand, energy efficiency and energy capacity for different residential urban applications was found to be socially and economic viable in achieving the primary research question for the current research. SWH system is a device that makes thermal energy available through absorption of solar radiation by heating water (Satam, 2013).

The researcher identified Msunduzi Local Municipality in Umgungundlovu District Municipality, Kwa-Zulu Natal- Pietermaritzburg as the research study area. Msunduzi Local Municipality is located along the N3 at a junction of an industrial corridor from Durban to Pietermaritzburg. The household growth is about 2% per annum, with Eskom and the Municipality providing electricity (EThekwini Municipality Integrated Development Plan, 2012-2017). The research introduces the topic by clearly delineating the research aim and objective on the role SWHs can play in supporting and promoting urban development.

Replacing electric energy or fossil fuel use for water heating with solar water heater system contributes to sustainable urban development (Gastli & Charabi, 2011). ‘Lin and Yang (2010), as cited by Pretorius and Van Rooyen (2013), state that the use of SWHs does not eliminate usage of electricity but reduces the usage significantly as the normal geyser will only switch on when the temperature does not get high enough to heat the water’. Hudon, Merrigan, Burch and Maguire (2012) supported this by saying that the hot water demand is greater in the morning or late evening which does not coincide with times of maximum solar radiation. Furthermore, an additional supplementary form of conventional system which provides additional heating is always necessary.

Wlokas and Ellis (n.d.) mentioned that changes caused by SWHs are greater at a household level than when looking at a poverty and inequality in South Africa. Austin, Williams and Morris (2003) revealed that adopting renewable energy (RE) technology offers the potential to create and sustain employment. Adoption of RE is viable in South Africa as the country faces two major challenges of pursuing economic growth and environmental protection.

One of the main objectives of South Africa's Millennium Development Goals is to reduce widespread poverty between 1990 and 2015. (Winkler, 2005) raised a concern whether the full potential for RE can be promoted given the high initial costs for the solar energy technology and the need to provide energy service to the poor. Wlokas (2011) stated that research on how people use energy; including the positive social contribution of SWHs on people's livelihoods has not been fully investigated. This is due to barriers in SWH industry which are perceived to undermine the objectives of the Millennium Development goals and prohibit urban development.

These include affordability and financing for installation of SWHs (Chang, Lin, Ross, & Chung, 2011). Another challenge is that it takes Eskom (the South African electricity supplier) about ten to twelve years to build a new power station; hence there is less capacity to meet the growing energy demand. To curb the problem, Eskom introduced a SWH programme to encourage energy consumers to switch to solar geysers (Pretorius & Van Rooyen, 2013). Winkler (2005) further stated that providing affordable, adequate and reliable modern energy supplies to energy consumers in South Africa is another challenge. This could be attributed with energy performance which is influenced by a number of environmental and technical factors (Gastli & Charabi, 2011).

Worldwide, hot water demand dominates the household's energy needs. In the developing world heating water is often the most energy intensive, the most expensive and time intensive (Johnson, 2007). Johnson (2007) is of the opinion that the solution to the use of biomass, electricity, liquid fuels (propane), limited access to meet hot water needs and increasing energy demand by the poor is by switching to SWH system.

2.1 Background to the research problem

SWH system dates back to the late nineteenth and the early twentieth centuries. It is acknowledged that heating water dominates the use of energy at household level worldwide (Odigwe, *et al.,* 2013). Developing nations have a continuing demand for energy as a basic service. The challenge is that fossil fuels contribute largely to GHGs, which shows the important role building sector can play in mitigating climate change and GHGs. This is due to high costs associated with water heating within households (Van Rooyen, 2013).

The demand for electricity in South Africa has increased rapidly since democracy in 1994. This is as a result of major economic and societal structural changes which South Africa has undergone; improved policy development replacing apartheid policies and provision of access to basic services including electricity provision (Andrade Silver & Guerra, 2009). Johnson (2007) supported this by stating that in developing countries, heating domestic water is often the most expensive and time-consuming process which requires intense household budgeting. Meyer (2000) found this to be true by saying that heating of domestic hot water consumes a considerable amount of energy in the residential sector in worldwide. Poor households have limited use to electricity because of the limited affordability; resulting in other sources of fuel being used e.g. paraffin, gas and fuel wood (National Development Plan, 2011).

South Africa is currently experiencing a shortfall in electricity generation capacity. According to Pretorius and van Rooyen (2013) there is a growing uncertainty of increasing electricity tariffs charged by Eskom. 'Winkler (2006), as cited by Chang *et al*. (2011, p.3), predicted that South Africa may double the future energy demand by 2050. The new solar energy generation can help meet the country's shortage of electricity, to prevent Eskom from implementing a countrywide load shedding which will retard economic growth. From 2008, Eskom prices for electricity supply were significantly increased to allow Eskom to recover all the costs incurred, build its reserves and to support Eskom's capital expansion programme. This is subsequent to the electricity blackouts encountered in 2008 from lack of capacity to generate electricity (Inglesi-Lotz & Blignaut, 2011).

The expansion programme entails increasing capacity of energy generation from coal by 10GW. Since 2008, electricity prices have increased up to 31.3 % in 2009/10, with environmental levy of 2 cent/kWh incorporated into the price increase (Edkins, Marquard & Winkler, 2010). In addition, electricity price hikes in 2009/10 increased relatively sharply from R0.33kW and were anticipated to increase to R0.66kW in 2013. To curb this energy crisis, Eskom has made considerable efforts to mitigate the energy situation which could potentially harm the country's economy.

In addition, many South Africans looked out for other alternative water heating systems. SWH system does not require any cost of electricity with low running costs as well maintenance costs (Chaudhari, Parmar, & Panchal, 2013). Eskom has rolled out a comprehensive programme of commissioning new power stations and upgrading the decommissioned ones. An energy-saving programme through use of renewable energy to ensure that by 2013 a national target of 10 000GWh is achieved was initiated. Eskom has made tremendous efforts to encourage households to switch to solar energy, by offering rebates on a portion of installation and purchase costs of solar water heating system (Baloyi, 2011). However, the researcher aims to investigate if this was the case in Buffer Strip; as massive adoption of solar water heaters was observed during a preliminary research study.

Ozdemir, Marathe, Tomaschek, Dobbins and Eltrop (2012) realized the need to reduce electricity consumption due to limited of capacity to generate enough electricity for the growing population and to limit the environmental footprint caused by conversion of electricity from coal. Jacobs (2008) added that hot water use contributes significantly to energy consumption in residential homes. 'Cawood & Morris (2002), as cited by Davis *et al*. (2011), concluded that water heating consumes 45, 9% of total electricity in suburban households i.e. 30, 2 in townships and 18 % in shacks'. Moreover, the energy demand for energy services differs depending on the economic inequalities. Solar energy in South Africa is believed to be one of the attractive alternatives for the country due to high solar radiation (Edkins *et al*., 2010).

Energy is essential to the continued existence of all human beings because it improves social and economic wellbeing (Odeku, 2012). SWH systems are regarded as the cheapest and the most affordable clean energy that can be made available to homeowners, with the primary benefit of providing hot water for the whole family (Patel[1], Patel[2], & Patel[3], 2012). Furthermore, the fact that solar energy can supply the present and future generations of the world with energy needs, means that it aims to promote sustainable development (Chavan *et al*., 2013).

Many low-income households in South Africa cannot afford electrical appliances such as hot water geysers and heaters. Due to this challenge, use of electricity for water heating and space heating increases energy expenditure. Qase & Anneckie (1999) indicated that energy initiatives have high potential to benefit the poor communities by reducing the amount of money spent on electricity. In South Africa, employment creation is a problem of national priority; therefore solar water heating industry creates a platform to provide jobs both in manufacturing and installation. South Africa must meet the new energy demand of 29 000 megawatts (MW) to meet the provisions of the 2030 vision. The research examines policy options implemented by the state that promote renewable electricity in South Africa.

The South African government's White Paper on Renewable Energy Policy has supported the establishment of renewable energy (RE) technologies. Through introduction of the National Energy Act, 2008 (Act 34, 2008), the South African National Energy Development Institute (SANEDI) was founded. SANEDI has been listed as a Public Entity in 2010 and started operating in 2011. SANEDI aims to fulfill obligations as set out in various government policies in alignment to South African Constitution and National Energy Act. SANEDI will partner with Department of Energy in its effort to achieve energy policy objectives. The primary objective of the National Energy Act, 2008 (Act 34, 2008) is to ensure diverse energy resources at affordable prices to strengthen economic growth and alleviate poverty. This includes efficient energy generation and consumption.

Another government policy initiative was through The White Paper on Energy Policy for South Africa (2008) which significantly improved the security of energy supply; by the ensuring that poor households access affordable energy services. The policy ensures that there is enough supply and consumption of energy in the next ten years in South Africa, and that the disadvantaged access the energy service at affordable costs. Energy Efficiency Strategy of the Republic of South Africa was used as a tool to develop and implement energy efficiency strategies. The Strategy was established as result of the country's increase in energy demand. South Africa is among a few countries in the world that have set detailed targets for energy efficiency improvements. South Africa has set the target of 12% through its Strategy to improve energy efficiency by 2015. This target is linked to its vision of affordable energy for all (DEAT, 2005).

In support of urban development, South Africa has rolled out millions of SWHs across the country and the reason for this is driven by the willingness of government to provide free hot water and to reduce the electricity demand. This improves the potential for solar water heaters while contributing to transition to a low carbon economy, through installing 5 million solar water heaters by 2030 in the country (EThekwini Municipality Integrated Development Plan, 2012-2017) and addresses the country's poverty, electrical challenge, reduce strain on existing non-renewable (fossil fuel) electricity sources, mitigate greenhouse gases (GHGs), while creating employment (Wlokas, 2011).

2.2 Research questions

The primary question for this research is as follows:

Do solar water heaters in Buffer Strip have potential to support urban development in the research area? In order to determine this potential, the research must address the following sub-foci?

I. Are solar water heaters an affordable technology?

II. Do solar water heaters generate household savings? How?
III. Do SWHs reduce the demand for electricity in your home?
IV. Was Eskom rebate available at the time of purchasing your solar geyser?
V. Do solar water heaters provide a reliable source of power? Why?

2.3 Research aims and objectives

The **primary aim** of this study is to investigate whether the potential for solar water heaters in Buffer Strip support urban development.

The **secondary aim** of the study is to develop a good qualitative understanding of the impact of urban development in determining the potential for solar water heating system in the South African residential urban areas (Holm, 2005).

This research aim will be addressed by means of the following objectives in order to investigate the potential for solar water heaters in urban development, namely to:

I. To establish the affordability of solar water heaters
II. To establish whether SWHs generate savings for Buffer Strip households
III. To assess if the use of SWHs reduce the demand for electricity in Buffer Strip
IV. To establish if there was any form of financial assistance from Eskom when SWHs were installed
V. To establish if SWHs can be used as a reliable source of power

2.4 Scope and scale of research

The scope and scale of study delimits and makes reference to focus the research area within Buffer Strip area falling under the jurisdiction of Msunduzi Local Municipality in Kwa-Zulu Natal, by determining whether solar water heating technology installed in the area has potential to support urban development. The study will focus on commercially produced solar water heaters and not homemade units and will entail literature survey on relevance of South African solar water heating publications (Holm, 2005).

3. LITERATURE REVIEW

The starting point to understanding the potential for SWHs in urban development is by presenting the work done by other academics which will form the basis of this research. Literature review reports have emphasized the reliable contributions of solar energy to sustainable energy production (Odigwe *et al.,* 2013). This research investigates the potential that may be realized through diffusion of SWHs in Buffer Strip residential urban area of Kwa-Zulu Natal and beyond. It constructs an argument by revealing the importance of urban development in enhancing the potential for SWHs in the South African domestic residential areas (Prasad, 2007).

The literature structure commences with the discussion of the importance of RE, potential for SWHs, global trends for SWHs. This will be followed by other pertinent aspects related to the research, which include energy efficiency, energy demand, The Rebound Effect, South African Case study Projects, opportunities and gaps emanating from the implementation of SWHs. The purpose is to evaluate the contribution that electricity from SWHs can make to reduce electricity load in urban areas, reduce peak demand and reduce electricity demand. While the potential for RE is hotly debated, literature studies agree that RE and energy efficiency are important in reducing negative economic, social and environmental impacts.

3.1 Renewable Energy

RE is one of the areas South African government undertakes; to manage the impacts on the environment by minimizing the use of electricity; and diversifying energy supply from the use of coal-dominated system (Prasad, 2007). With the increasing demand for energy and rising fuel costs i.e. oil and gas; solar energy is considered the preferred source of RE that can be used for water heating both in domestic homes and commercial industries. Urban development enhances sustainable use of RE technology and promotes the implementation of SWH projects that support urban development in the country (Wlokas, 2007). The implementation of RE technologies in South Africa faces a challenge because South Africa relies heavily on coal to meet its energy needs (DME, 2004); and coal is among the cheapest forms of electricity supply in the world

(Visagie & Prasad, 2006). While energy promotes social and economic development; the way it is produced, transported and used can contribute to environmental degradation such as pollution and climate change (Winkler, 2005).

Government, industry and academic institutions have made a collective effort in finding alternative sources of energy instead of carbon intensive energy sources (Muhammad-Sukki, RamirezIniguez, McMeekin, Stewart & Clive, n.d.). In order for South Africa to achieve RE targets of 10 000 GWh in 2013, use of RE as a sustainable resource should be promoted (Eskom COP 17 Factsheet, n.d.). In support of RE (Winkler, 2005) indicated that the theoretical potential for RE in South Africa is huge. Chang *et al*. (2011) supported this statement by indicating that SWHs are a form of RE technology with potential to empower government and individuals to put more effort towards mitigation of climate change and to reduce the level of GHGs.

It has been evident that South African government's White Paper on RE Policy of 2003 has supported establishment of RE technologies. However, Chang *et al*. (2011) felt that renewable electricity still contributes less than 1% of the electricity generated in the country.

3.2 Potential for SWHs in developing countries

In developing countries SWH technology is introduced for two reasons; mainly for the benefit of the poor to have access to electricity; unlike in developed countries where its introduction is for reduction of GHG emissions (Devabhaktuni *et al*., 2013). Devabaktuni (2013) highlighted that basic access to electricity means reduction in burden of energy production. In contrast, Prasad (2007) argued that dissemination of SWHs in South Africa has not reached its full potential even though South African government has intervened through SWH programmes. This potential is based on technical and financial aspects of the project implementation such as suitability of high pressure and low pressure systems, reduction of emissions, energy crisis.

3.3 Potential for SWHs Internationally

In India, the estimated potential is 140 million m^2 whereas the actual installed capacity is 1.5 million m^2 which is 1.1% of the estimated potential. Research has not revealed the basis of these potential estimations, both in India and the rest of the world (Pillai & Banerjee, 2007). Devabhaktuni *et al*. (2013) agreed that solar energy is clearly a promising option and may sustain the lives of the millions of the underprivileged people in developing countries. Solar technology offers great potential when it comes to supplying the world's global needs (Madhigiri, 2012). Devabhaktuni *et al*. (2013) states that there has been an increase of global population in just one generation, with developing countries contributing to this significant increase and this contributes significantly to the increasing global energy demand in residential urban areas.

3.4 Energy Demand in Residential Urban Sector

In South Africa SWHs were rapidly distributed to the general public especially the poor households in the late 1970s and 1980s. After 1994 the new democratic government electrification of the previously disadvantaged populations was identified as a priority area identified in the Reconstruction and Development Programme (RDP). Even after poor households were connected to the national grid, many were not able to afford it. Meaning that the use of electricity was restricted (Prasad, 2007).

The demand for energy has resulted to introduction of clean technologies to adopt a more sustainable energy mix. SWHs reduce the overall energy demand of a household by up to 70% and GHGs significantly (Ozdemir *et al*., 2012). Pretorius & Van Rooyen (2013) acknowledged the contribution to reducing the energy demand through introduction of Eskom Demand-Side Management (DSM) as a strategy which is aimed to assist energy consumers to reduce electricity. The DSM entails planning, implementation and monitoring energy strategies to modify and reduce energy use while encouraging rolling out of the solar technology (Catherine, Wheeler, Wilkinson & de Jager, 2012).

For mid and high income groups, SWHs are the most suitable option as they decrease consumption of fossil energy and reduce the household’s expenditure for energy services. For lower income groups the benefits become more evident as utilization of SWHs increases access to energy services; improve the quality of life and lessen the financial burden of the poor to meet their energy needs (Ozdemir, Marathe, Tomaschek, Dobbins, & Eltrop, 2012). In contrast, (Devabhaktuni, 2013) had a concern with uncertainty that the energy demand is increasing at a rate proportional to the economic growth, which then would require developing countries to double the energy capacity in order to meet the growing demand. This is true as international donors support SWH rollout in South Africa; in particular the low-pressure systems which are predominantly supported on government social housing projects (Rennkamp, 2012).

Winkler (2005) clearly states that the objectives of government energy policy are to increase access to affordable energy services, improve energy governance, stimulate economic development, manage energy related environmental impacts and securing supply through diversity. In contrast Winkler (2005) had a different opinion to this and emphasized that the focus of diversification has been on gas rather than RE sources.

Residential sector consumes around 17 % of the total energy supplied by Eskom during non peak times but this value can increase up to 30% during peak times. Eskom has long term goal of saving 8000 MW in 2025. Table 2 below depicts the breakdown of how a typical residential home uses electricity; with water heating consuming most of the electricity (Catherine *et al*, 2012).

Table 2: Residential energy consumption breakdown Catherine *et al*. (2008)

Application	kW/year	(%)
Water heating	4259	36.1
Washing	326	2.8
Cooking	2447	20.7
Space heating	404	3.4
Refrigerator/freezer	1829	15.5

Lights	1766	15
Other appliances	766	6.5
Total	11797	100

3.5 Energy Efficiency

The literature demonstrates clear international support for energy efficiency in residential sector with focus being on household's savings and reduction in energy demand (Odendaal & Morar, 2013). It is clear that energy efficiency through SWH in the residential sector is the goal of government. Brazeau & Edwards (n.d.) are of the opinion that energy efficiency of water heaters must consider energy input to heat water, energy output which generates heated product water and losses of heat to the ambient environment and along the pipelines. Adoption of democracy by South African government allowed robust energy efficient interventions which aimed to reduce energy consumed; energy demand, energy needed and energy supplied to residential households (Davis *et al*., 2010). Moreover Davis *et al*. (2010) perceived solar energy as an emission reduction strategy for atmospheric pollutants and reduces costs of providing energy service. The power crisis in 2008, sharp increase in electricity prices and the pressure to mitigate carbon have led to the attention being given more on energy efficiency. Davis *et al*. (2010) identified energy efficient initiatives and strategies which may benefit the residential sector; which entail consideration of RE.

RE potential can support urban development only if energy efficiency, expansion in SWH market, rebates, technical skills, product quality, standards, initial investment costs for installation, energy demand, and energy supply are considered. Energy efficiency minimizes the growing demand to consider alternative options of energy supply which are believed to be more sustainable and clean in order to reduce reliance on fossil fuels (Banks & Schaffler, 2006). The involvement of international funders like The World's Bank's Clean Technology, the British High Commission, and conventions like Clean Development Mechanism and conferences like COP 17 create an incentive for South Africa to prioritise growth in energy efficiency.

Energy efficient lighting, energy efficient residential building designs, energy efficient appliances, fuel switching, government policy to regulate energy demand and supply seem to be the most attractive ways applicable to achieve energy efficiency. Davis *et al.* (2010) indicated that the intention of energy efficiency is to reduce the way energy is consumed and the way it is procured. This is supported by the statement made by Davis*,* Cohen, Hughes, Durbach & Nyatsaza (2010), that energy efficiency reduces the costs of providing energy service.

South Africa has followed China's footsteps by making it mandatory that all buildings (low cost, mid and high income houses) should have designs that are energy efficient. This can save households spare money while reducing space heating requirements in winter. The other energy efficient strategy was to encourage the shift of electricity demand by domestic households at peak periods to off peak periods; and reduce and to reduce energy consumption during off peak period through installation of energy efficient equipment (7-10 am and 6-8pm) (DEAT, 2005). Chaudhari *et al*. (2013) are of the idea that reliability and efficiency to improve performance of SWH system can be strengthened further. The performance largely depends on the collector's efficiency at capturing the solar radiation and transferring it to the water (Satam, 2013).

3.6 The Rebound Effect

Davis *et al*. (2010) identified and examined potential rebound effects on households using SWHs. The rebound is referred to as the effect resulting from energy efficient interventions with regards to water heating which is regarded as significant in developing countries. SWH users become rebound to the previous economic situation which had previously improved as a result of SWH utilization. SWH users notice significant energy savings from use of SWH. This changes human behavior to misuse electricity by taking longer showers and cooking or purchase electrical appliances which will consume more electricity rather than saving it (Davis, Prier, Cohen, Hughes, Durbach & Nyatsaza, 2011).

According to Cawood and Morris (2002), SWHs in South Africa were not tangibly supported by government. This was aggravated by the lack of institutional and financial support for SWHs and other renewable sources, general reduction in disposable income of middle income households. Though there has been a renewed interest in solar technology over the last decade due to concerns about potential emission reductions, reduction of global environmental problems (mainly climate change), increased electricity tariffs, energy security, generation capacity, electricity supply; the question is whether the current state of urban development promotes optimal use of SWHs in South African residential urban areas in a manner that realizes full potential.

3.7 Innovative Financing Mechanisms

It has been indicated that at the end of 2012, more than 85 % of South African homes had access to electricity. The initiative of the South African government to install SWHs is driven by high expectations for the positive impact of solar water heating. This is associated with the country's support of "Go Green" its initiative i.e. huge demand for clean technologies, reduction in overall electricity usage (Pretorius & Van Rooyen, 2013); improve Eskom's energy capacity to meet the future energy demand, increase in accessibility of electricity.

Eskom provides rebates to households when installing a solar geyser. The rebate consists of total cost of the heating system i.e. costs associated with investing in the solar technology including installation (Pretorius & Van Rooyen, 2013). 'Hessami (2006), as cited by Pretorius & Van Rooyen (2013), support adoption of initiatives contributing to economic growth such as Eskom's initiative by emphasizing that countries such as Australia have followed the same approach to motivate citizens to install solar geyser through provision of subsidy.

3.8 Global Advancement of SWHs

At a global level, solar water heating is a technically and a commercially mature renewable heat option for domestic hot water. Worldwide, SWH technology contributes largely to global energy supply compared to all other solar technologies (Haselip, Nygaard, Hansen, Ackom, 2011). SWH technology has long been in existence and its rapid advancement is apparent in China. The speedy rate at which Chinese consumers installed SWHs on their rooftops is the belief that they are cheap to use; even though they are expensive to install, which is no different to South African situation. However, the speed of SWH development lags behind Chinese residential development.

This is contrary to the situation in South Africa, as China has made tremendous improvements by improving the standard of solar technology. This is characterized by expansion of manufacturing facilities, improved product quality, publication and implementation of national and industry standards (Bosselaar *et al*., 2004). A similar study was conducted in Inland Norway; to assess potential for solar technology and investigate the possibility of using the SWH technology for residential application. The findings of the study revealed that, solar energy use for water heating is competitive and viable even in low solar potential areas. The study also reveals that the energy use in households stands at 77%; of which 65% of household's electricity consumption was used for heating (Hagos, [1, 2], Gebremedhin, [1] & Zethraeus [2], 2014). According to Winkler, Spalding-fecher, Tyani, and Matibe (2002) a clear international support for energy efficiency through previous literature has been demonstrated, with household savings triggering a need for reduced energy demand.

3.9 Case Study Projects

In South Africa, solar energy is mostly used to produce electricity and to heat water in residential sectors. A few SWH case study projects have been evaluated and depict the success and the potential for SWHs in urban development in South Africa. The projects have shown tremendous socioeconomic contribution towards poverty alleviation. These include Africa's first Kuyasa Clean Development Mechanism (CDM) project in the Western Cape. This project demonstrated positive developmental impacts, leaving 96% of the houses connected; with annual savings on energy expenditure per household around R625 and improved health (Wlokas, 2011). Being a CDM project creates an option to make use of the Eskom rebate program (Rennkamp, 2012). In Kuyasa project women seemed to acknowledge the positive impact caused by SWHs in their households.

The second project is Zanemvula Solar Water Heating Project in the low-income settlement of Boysen Park, Port Elizabeth. In this project, government incorporated installation of SWHs on approval of residential development in 2008. The project reduced the energy demand, reduced energy costs and maintenance costs of implementation became the responsibility of government. In both projects, project implementers noticed language barrier as a concern, which undermines the integrity of qualitative research and hinders interaction with the researched and the researcher (Wlokas, 2011).

In Gauteng, SWHs have been found to have reduced up to 70% of the overall electricity demand GHG emissions significantly. In Durban, initiatives to improve energy efficiency in residential homes have been initiated by implementing scaled tariff structures to encourage energy conservation. In Kwa-Dabeka hostels; out of the 14 000 residential units; around 25 % have geysers for water heating. The increased energy efficiency as energy consumers limited their use of two plate stoves, resulting in low energy consumption (EThekwini Municipality, 2014).

As the qualitative researcher, rich descriptive data was collected and validated for inductive interpretation using an ontological approach to show interactive relationship between the SWH potential and urban development, an epistemological approach to understand how SWH technology home owners in Buffer Strip create meaning from the solar technology used; and the cosmological approach to understand how their social and economic wellbeing have been transformed since adopting the technology.

4.0 Technical, Financial and Legislative Barriers

There are numerous SWH energy aspects identified as barriers limiting the dissemination of SWH technology. These include economic considerations (financial incentives cost of electricity, capital cost, income and expenditure), corporate social responsibility (GHG emission and global warming), technical support (training program, quality assurance and standards) and regulations (housing projects). Dependency of people on salaries and social grants in South Africa limits investment in solar water heaters due to high capital costs, which in turn limits the market expansion (Chang *et.al*, 2010).

In support of the South African government initiatives, South Africa has established SANS 6211-2:2003 standard and this contributing to a positive acceptance of the consumers. However, the standards for quality testing of solar collectors have not been developed, which could be a serious obstacle in further developing solar collectors (Chang *et al.*, 2010). Nyantsaza, Davis, Merven & Cohen (n.d.) are of the opinion that conducting energy initiatives with awareness may be useful in anticipating savings; reducing demand; increasing power capacity and the reserve margin rather than focusing on efficiency initiatives alone. This results in detrimental effect in terms of affordability over the past years; with a 25% average annual increase approved by the National Energy Regulator of South Africa (NERSA). Research has documented the effect of the sharp increase in electricity tarrifs in Gauteng; with households spending more than 10% of their income on energy services (Ozdemir *et al*., 2012).

The SWHs are expensive which retards the growth of market in South Africa (Visagie & Prasad, 2006). Their low temperature absorption ranging from 100^{o}-150^{o} results in high capital costs, may have attributed to the low energy density of the sunlight and the complexity of the solar technology. It is estimated that the use of SWHs will in the urban areas reach up to 50% in 2030.

Table 1: Penetration rates of solar water heaters and geyser blankets for 2030 (Winkler, 2009)

Household	SWH 2030	Geyser Blankets 2030
Urban rich	50%	20%
Urban poor	30%	20%
Rural rich	30%	20%

Rural poor	30%	20%

Various government regulations are being explored to make solar heating systems mandatory in residential developments. Some of the constraints in rolling out of SWH were identified to include: aesthetics, maintenance costs associated with time, money and convenience, adapting to the new solar energy technology, limited ability to monitor savings, repairing of the new technology. It is argued that there is no official evidence on the level of satisfaction among the new users using SWH technology (Davis, 2011). These barriers hinder urban development due to high initial investment costs of SWH systems (Van Rooyen, 2013).

4.1 Suitability of SWHs in solar radiation

SWHs are used worldwide as devices that harness energy from sunlight (Chavan *et al*., 2013). In South Africa, heating of domestic water relies mainly on glazed and unglazed flat-plate collectors which both use sun rays and evacuated tube solar collectors which produce higher temperatures than flat plates (i.e. they are high-energy efficient). Evacuated tube solar collectors only account for slightly more than 5% of glazed solar collectors in South Africa. Approximately about 1000 times the global energy requirement can be harnessed through proper use of solar energy. The suitability of SWH is measured by the performance (no maintenance costs) and reliability of the individual SWH system (Pretorius & Rooyen, 2013). However, only 0.02% worldwide of this solar energy is utilized (Devabhaktuni *et al*., 2013). Figure 1 below demonstrates diffusion of SWHs in Buffer Strip.

Figure 1: Solar Water Heater Installation in Buffer Strip

4.2 Solar Energy Generation

Energy demand increases at a rate proportional to economic growth. This means that developing countries need to double their installed generation capacity in order to meet the growing demand for power by 2020 (Devabhaktuni *et.al*, 2013). The Energy Minister, Mrs Peters, announced that one million SWHs would be installed by 2014. This has been observed from the spread of installations throughout the country. The installation directly links to recent updates on statistics which show that 81.5% of households nationally are connected to electricity grid. In the Western Cape Province, low-pressure evacuated tube SWHs are installed with 96 % of the houses electrified. Eastern Cape ranks second in SWH installations, where 70 % of the houses have a municipal electricity connection (Wlokas, 2011).

More than 38 000 high pressure and 84 000 low pressure systems have been rolled out nationally, resulting in energy savings of about 60GWh per annum. In addition, South Africa's SWH market has significantly grown over the years, from only 20 suppliers in 1997 to more than 400 suppliers in 2011 (Eskom COP 17 Factsheet, n.d.). The market for SWHs in South Africa increased to an average of 42 % between 1979 and 1983, while there has been an increased growth from 2007 (Edkins, Marquard & Winkler, 2010). In South Africa SWHs are installed free of charge and are financed through an Eskom subsidy and Carbon Credits (EThekwini Municipality Integrated Development Plan, 2012-2017). South Africa's energy capacity is insufficient and this has led to power shortages in some parts of the country; which triggers the need to reduce energy consumption.

4.3 SWH Opportunities in Residential Urban Sector

Economic benefits of SWH technology include homeowners making considerable savings in the manner in which they use their electricity and environmental benefits are impressive. Research has shown that SWH systems reduce the monthly costs of electricity of a conventional geyser by 40%. Within three to four years after purchase, an installed solar geyser will repay itself, depending on the hot water consumption of the household and location of household. Pretorius & Van Rooyen (2013) indicated that a reliable solar geyser will not require any maintenance, and therefore no maintenance costs and that the life span is about 15-25 years. In spite several initiatives, policies by government and investments to improve energy capacity; lack of access to electricity is one of the major reasons why most of the citizens in developing countries are still poor (Devabhaktuni, *et al*., 2013)

4.4 Existing gaps and shortfalls

While there are many sustainability claims regarding the use of SWHs, some research study has been conducted which assessed residential water heating infrastructure performance in terms of public health, environmental impacts and consumer drivers. The study referred to herein reveals that there has been very limited research assessing water quality, health factors and comparative energy efficiency associated with these initiatives (Brazeau & Edwards, n.d.).

The Renewable Energy Policy Network for the 21st Century speak about solar water heating as having the potential to partially or wholly substitute the use of electricity in areas with sufficient solar radiation (Wlokas, 2011). The financial aspect of SWHs is found to be the major benefit for households. Securing CDM funding in South Africa will significantly lead to cost effectiveness from the household’s perspective.

4. RESEARCH METHODOLOGY

The research study will feed into the existing SWH research by investigating the potential for SWH potential in Buffer Strip residential households and hopes to establish the barriers towards the adoption of solar technology in the residential sector in South Africa. In order to achieve the objectives of the research a comprehensive methodology approach was conducted involving a random visitation of twenty solar technology home owners using SWHs in Buffer Strip. Research adopted a qualitative approach in-order to provide an insight of the situational analysis and establish the potential of the existing SWHs in urban development.

The research method aims to investigate how urban development in Buffer Strip has influenced the potential for SWH technology in the area. To investigate the potential for SWHs and achieve the set objectives, a qualitative research design was followed using twenty questionnaires as a source of empirical data. The final research was completed with the hope that it will contribute to the improvement of human lives (socially and economically), inform urban development through SWH technology, explore the potential benefits and drawbacks which SWH technology offers. This will enable additional future research and policy improvement on SWH potential which influences the lives of the poor in urban residential areas. The qualitative aspect of the design also aims to understand energy efficiency initiatives of SWH technology by considering the views of the Buffer Strip local people.

The research methodology describes the research design and research processes that were used to complete this research report (Du Toit, 2010). With constant annual rate increases and sharp electricity hikes imposed on South African citizens by Eskom; the study has found to be economically viable and feasible for households in the urban residential sector. With the high costs of electricity limiting the affordability while increasing monthly electricity bills; SWH is recommended as an alternative source of RE as it make the most economic sense by reducing the monthly costs (Pretorius &van Rooyen, 2013).

In favour of a qualitative approach, the research objective is achieved through a qualitative approach to give effect to the concept of urban development which is promoted by a socioeconomic structural change. The selected approach brought fruitful benefits in the study conducted by (Du Toit, 2010) in order to understand the less quantifiable psychological benefits of installing SWHs in low income households as well as well as the barriers to energy cost reduction are in the minds of the consumer perspective. Du Toit (2010) understood that fundamental human needs cannot be fulfilled without understanding these barriers.

The research problem was identified to address the reliance of ordinary residents residing in Buffer Strip and evaluate their resilience in change of mindset towards the use of SWH. This evaluation was done using a systematic and logical approach applied by (Du Toit, 2010); by evaluating the way people perceive the role of SWHs in poverty reduction and provision of bulk heated water in order to meet their growing energy demands. The barriers identified in this literature review for fair adjustment of high capital investment costs for SWHs are some of them the reasons (Du Toit, 2010) discovered in the study conducted. In addition to the ideas of existing research, this literature illustrates the reasons as to why SWHs are recommended as an alternative source of solar energy.

Improved socioeconomic dynamics support urban development; which in turn yields positive results for the economy at a national and household level. This literature review forms the basis of this research methodology which is supported by sustainable energy interventions. All these interventions highlighted in this literature review advocate the concept of sustainable development urban development through diffusion of SWHs. This research calls for the South African government to apply an integrated and holistic approach when it comes to meeting the energy demands of the ordinary citizens. Barriers identified in this research should be the noted as the beginning of a brighter future; when it comes to meeting the basic energy needs and demands of the energy consumers. The qualitative questions asked from respondents in Buffer Strip aimed to identify the perceived barriers illustrated in literature review; which relate to affordability, household’s income, reliability due to technical, financial aspects, increasing energy demand, high purchasing costs to name a few should be the priorities of South African government to uplift the current state of urban development.

The methods used for data collection involved Buffer Strip residential urban household visits with the purpose of gathering primary qualitative raw data by means of questionnaires and photographs to capture and reveal the current scope of solar technology use. The visitation entailed a random selection of twenty home owners. The qualitative approach established whether home owners have continued interest which promotes adoption in the use of SWHs. The user friendly questionnaires were administered to twenty participants who then responded to the questions during the enquiry. The respondents selected were the source of the researcher’s empirical data. The empirical data used primary textual data and gathering of existing sources.

The questionnaire comprised of five closed-questions (structured). Some questions were included open ended questions to obtain rich descriptive and exploratory research qualitative data. This mix of questions allowed the researcher extract meaningful and detailed information. The participants expressed themselves honestly about how SWHs support urban development specifically in Buffer Strip. Subsequently, qualitative data interpretation and inductive analyses was conducted by the researcher without changing the original views of the participants. The researcher adopted this inductive approach in favour of an interpretive research tradition to evaluate the potential for this new generation of solar technology. Participants were afforded an opportunity to raise their concerns and their beliefs. This enlightened the researcher to understand whether there is possible demand for SWHs in the residential urban sector in future.

The qualitative research examined a few case studies in which SWHs were installed in low-income households in some Provinces within South Africa. The data collected before and after installation during the household surveys revealed that installation of SWHs contribute positively to poverty alleviation, improved energy security, improved household capitals, health benefit, and time and energy savings (Wlokas, 2011).

Qualitative research is an approach rather than a particular design of techniques (Welman, Kruger, & Mitchell, 2012). For instance; in a case study where SWHs were installed on two low-income houses in Stellenbosch, a qualitative approach was primarily adopted. Two particular households were offered an opportunity to observe first-hand the impact that SWHs have on improvement of their lives. The insights informed the argument for the mass rollout of SWH (Du Toit, 2010).

Maree (2012) noted that paradigmatic assumptions and perspectives impact significantly on the methodological choices; and demand different a consideration of different approaches. It is therefore in the interest of this research to consider the characteristics of Maree (2012) through adoption of an idiographic approach which particularly focuses on individual behavior and uniqueness of each particular situation. In the light of opinion presented by Van Maanen (1979, p. 520) as cited by Welman, Kruger, & Mitchell (2012), qualitative research is described as an interpretive technique which seeks to describe, translate and come to terms with the social world. Therefore, qualitative approach is a descriptive form of research (Welman, Kruger, & Mitchell, 2012).

Research designs: The researcher used the following research designs as a means of investigating the potential for SWHs in the study area. The research questions were developed using the designs specified.

Phenomonology was used by researcher since it focuses on lived experiences from the participant's point of view. The assumption behind phenomonology is that its essence is derived from shared experiences (Letts *et al*., 2007). Understanding people's perception on whether potential for SWH energy is likely to increase in future in South Africa. Ethnography assisted the researcher to understand the inner attitude and perceptions of participants towards use of SWH technology in the study area. Welman, Kruger, & Mitchell (2012) were of the opinion that ethnography describes the community or group by focusing on social systems. This opinion assumes that all human behavior is intentional and observable; hence this research is oriented towards understanding the reasoning behind people's actions. In support of ethnographic study, this research has researched the participants as the primary source material and observed their lives. Eventually the researcher eventually compiles data in a way that creates a full picture of the group under study (Maree, 2012).

Action Research was used as an appropriate tool; to look back at the progress and success of South African government in supporting urban development through implementation of SWH projects which influence their potential. Action Research is aimed to create a platform for South African government to improve the current scope of SWH technology in the country's residential urban areas. Welman, Kruger, & Mitchell (2012) had a similar view that action research finds a solution for a particular practical problem.

A few South African case study projects were used as examples to demonstrate the potential SWH diffusion has on urban development. The success stories of these SWH projects using these case studies informed this data analysis and interpretation. For example, Du Toit (2010) conducted a case study in Western Cape low-income houses but analyzed the developmental potential for SWH technology quantitatively and qualitatively. But for this research, the researcher preferred to use only a qualitative approach using questionnaires as a data collection method. Questionnaires were used to study different perspectives of the sample population using SWH system in the selected research study area.

Selecting a phenomenological approach enabled the researcher to explore the experiences of the people with SWH system who were participants in this research study.

The picture created through selection of ethnographic design enabled the researcher to report what people do and say; analysis that reveals the social structure and world view of the group. The overarching themes from participants were of story telling of the improved household energy efficiency, reduction in electricity demand, cost effectiveness, and affordability to purchase and to install SWH system.

Action research provided a platform to finding solutions to the barriers identified in this research; which limit diffusion of SWH system in the urban sector. Providing solution to the current barriers identified in SWH diffusion will improve the SWH potential and improve urban development. The case study research; in consideration with the existing case studies used in this research to investigate the issue under investigation will give a voice to the powerless and voiceless.

Data collection/gathering techniques

The aim of the research was to investigate the factors influencing SWH technology potential in urban development. The questionnaire used in this research is incorporated in Appendix A. The questionnaire is well established tool within social science research for acquiring information on participant social characteristics, present and past behavior, standards of behaviour or attitudes and participant's reasons for action for the topic under investigation. The point of having a questionnaire is primarily to have all the data in more or less the same format, which means that all questions are asked of the whole population in a precisely the same way (Bird, 2009). Compilation of user friendly questionnaires was done well in advance. Questions consist of structured and semi-structured questions. With this in mind, a combination of closed and open questions provides the survey write up with quantifiable and in-depth results. Closed question produce results that easy to summarise and clearly presented in quick-look summaries while open ended questions produce verbatim comments adding depth and meaning (Bird, 2009). Survey questionnaires were used to collect qualitative empirical data generated from research questions.

Respondents in Buffer Strip provided insights into factors influencing diffusion of SWHs. This research studied the extent of utilization of SWHs and whether the current household users perceive SWHs as an efficient solar energy technology to invest in-in future. According to Bird (2009), the first step to building rapport laying the groundwork is through initial contact in the form of a cover letter; with researcher introducing themselves and their credentials, explain the study and why it is being conducted, reveal why the person was being selected for the study, indicate how long the questionnaire take to complete and the intended use of the results.

Sampling and sample description

Sampling refers to the process used to select a portion of the population for study (Maree, 2012). The sampling technique determines how the representative sample is of the population of interest. The characteristics of the population selected include age, socioeconomic status, education, gender. Based on these characteristics; a representative sample was chosen where every member of a population had a statistically equal chance of being selected (Bird, 2009). The researcher has chosen criterion sampling to select participants. This is because the typical characteristics already mentioned; of the participants to be included were decided on at the design stage of this study. According to Maree (2012); criterion sampling may include the place of residence and assist in selecting the participants most likely to possess the experience, or know about, or have insight into the research topic.

The majority of the sample surveyed was females, making up 80% of the population, while male respondents comprised a mere 20% of the total population surveyed. Table 1.1 in Annexure C gives a summary of the sample description. Twenty randomly selected households currently using SWHs in Buffer Strip were visited and participated. Respondents were visited individually in each of the households, with questionnaires explained by the researcher where necessary. With the semi structured questionnaires used, participants were made to select from pre-determined answers; which led to data analyses to be conducted qualitatively (Harris & Brown, 2010).

Each questionnaire was completed by each participant on each day of data collection. The first section was intended to collect personal data of respondents and to investigate the reason why SWH users were attracted to the technology. Participants included Zulu and Xhosa males and females of 20-70 years of age; ranging from those with no formal education, with primary school, high school, college or university.

The second section was to obtain the household profile, which included number of persons per household, monthly income per household, monthly expenses, monthly expenditure and the fuel type used. This allowed the researcher to establish whether the use of SWHs influences electricity demand. The third section aimed to identify access to social grant and how it impacts on the people's livelihood. However, very few of the participants rely on social grants to sustain their livelihood.

The fourth section identifies the poverty status and whether Eskom rebate led to the increase to the wide use of SWHs in the area. The fifth section aims to establish energy efficiency of SWHs in terms of people's affordability, generation of household savings, reduction in the demand for electricity, and whether the use of technology is reliable. Questionnaires and photographs were taken in the field to reveal the status quo of SWHs and whether how urban development has been influenced.

The researcher complemented the primary raw data by using the updated secondary sources (i.e. documents) including journals, books and published research articles. Secondary data sources assisted the researcher in determining this potential in the residential sector. Data analysis below illustrates how the researcher critically conducted the analysis for this research. This was done as an attempt to answer the primary research question and sub-foci.

5. DATA ANALYSIS

It is important to highlight that the material presented and included herein comprises the actual responses made by the respondents in Buffer Strip. After data was collected, the results were descriptively analyzed and captured on computer excel spread sheet. Data analysis involved the use of frequency distribution of scores converted to percentages (White, 2003). This allowed the researcher to organize; summaries and interpret data in a meaningful way. Raw data from open and closed questions was converted into numbers. The data was organized in variables i.e. each question on the questionnaire represented a variable. These variables characterize the group of individuals who participated in the research study with differing opinions.

Content analyses technique was used to evaluate the frequency and saliency of particular words in the original text data to identify to identify keywords and repeated words. Content analysis reduced qualitative information into numerical terms (frequency, percentage and cumulative). The data was then presented in a form of frequency tables and cross tables, graphs and pie charts and later interpreted.

Demographics

This research was designed to investigate whether respective backgrounds with of the respondents regards to qualifications had any influence in the choice to invest in SWHs. The findings regarding demographics in the study area are depicted in Figure 1.1 of Annexure C. It must be noted that 80% of household females participated in the research study with only 20% of males participating. This means that the dominant perceptions used to inform the findings of this research and establish the potential for SWH in Buffer Strip were mainly provided by female respondents.

Energy Efficiency

The first aspect this research investigated was the affordability of SWH technology based on their experience; taking into consideration of financial savings. The results are shown in Figure 1.2 of Annexure A. Research findings revealed that 15 (75%) of the household respondents generating savings on electricity costs is what attracted them the most to adoption of SWHs while the remaining (5) 25% had different other opinions. Table 1.2 of Annexure C

Figure 1.2 to Figure 1.5 in Annexure A provides answers as to why Buffer Strip respondents chose to adopt SWHs for their household activities. Most participants did not use SWHs because of high rate of unemployment; because only a small fraction of about 2 (10%) respondents confirmed that their attraction to SWHs was due to high rate of unemployment. Only 5 (25%) said that the attraction to the use of SWHs was for the purpose of saving household budget, while the other 25 % said their attraction was driven by the need to get hot water in their households. Cumulatively about 100% of overall Buffer Strip residents use SWHs for heating water; for bathing and for cooking. This could be attributed to the fact that SWHs use free sunlight.

To establish the significance of SWH potential in urban development, the researcher investigated the most common form of fuel used in Buffer Strip households. The study shows that SWH system is a preferred technology in favour of electricity because of its beneficial effects for different household activities. Figure 1.1 to Figure 1.3 in Annexure B illustrates that 13 (65%) of the participants mainly rely on SWHs for heating water; (20%) still use electricity while the remaining 3 (15%) are of the opinion that SWHs do not meet their energy demands by providing sufficient hot water in winter. The 15% mentioned that heating water using SWH generates extremely hot in summer when the solar energy demand is low.

Heating water will require less electrical energy using fossil fuels; reduce energy demand and energy consumption; while generating more household's economic savings particularly for the residential sector which mainly depends on electricity for heated water.

Reliability as a source of power

Table 1.4 in Annexure C shows that 19 (95%) of the respondents felt that SWHs are a reliable source of power. The research further wanted the respondents to give reasons to substantiate this question. Different responses were given as shown in Figure 1.5 in Annexure B; which include; availability of free hot water, higher heat retention and no time spend in heating water. Other reasons to respond to the reliability of SWHs are mentioned below.

Technical design

One participant associated SWH reliability with the fact that it has not given any technical problems since lasted installed in two years. This literature has revealed higher initial investment costs of SWHs; but operational costs are found to be far cheaper as there is no maintenance required which makes them economically viable for end users (Chang *et al*., 2011).

Electricity consumption and electricity costs

Another aspect raised by many was linked to reduction in electricity consumption with less electricity costs. Reduction in electricity consumption reduces energy demand; energy production; improves Eskom energy generation capacity; increases access to energy services; improve the quality of life and lessen the financial burden of the poor to meet their energy needs (Ozdemir *et al*., 2012). This attraction to diffusion of SWHs by respondents will obviously reduce the increasing energy demand in the Buffer Strip residential sector; while contributing to less spending in order to meet their energy needs.

Installation costs

One participant said only installation costs are involved since the operating costs are free.

Dependency factor

Three respondents raised that they depend mainly on it. Two of the respondents said this dependency is more in summer than in winter, as it does not provide hot water when needed the most.

SWH is not functional

Only one respondent said that the SWH is not functional at present. This proves the success of adoption of SWH system at a household level. This is because many of the respondents still have access to heated water at no cost from the SWH implementation in Buffer strip; which reduces the electricity energy consumption and improves energy efficiency.

Availability of Eskom rebate at the time of purchasing solar geyser

Figure 1.6 in Annexure B depicts the perspectives of the respondents with respect to the question. 13 (65 %) said that there was no Eskom rebate, while 6 (30) respondents believe Eskom rebate was available on time of purchase. One participant was not sure whether it was available or not. Not all respondents were certain about who received a subsidy on installation of a solar geyser; but through this literature it was discovered that the costs associated with investing in the solar technology on installation are significantly reduced (Pretorius & Van Rooyen, 2013). This same applies to the respondents in Buffer Strip since they now are spending less for energy service.

Annexure A

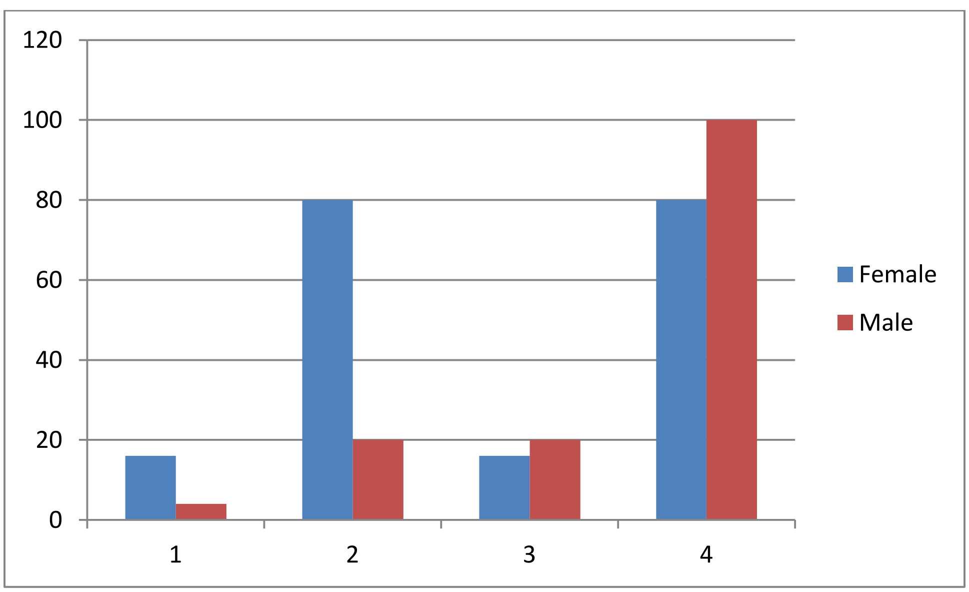

Figure 1.1: Profile of the number of participants in the study area

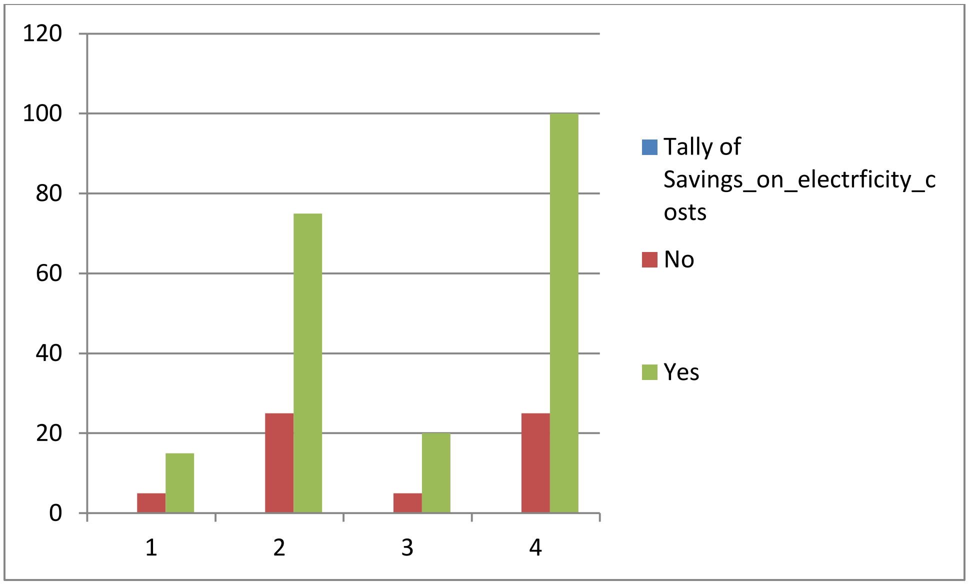

Figure 1.2: Household electricity cost savings

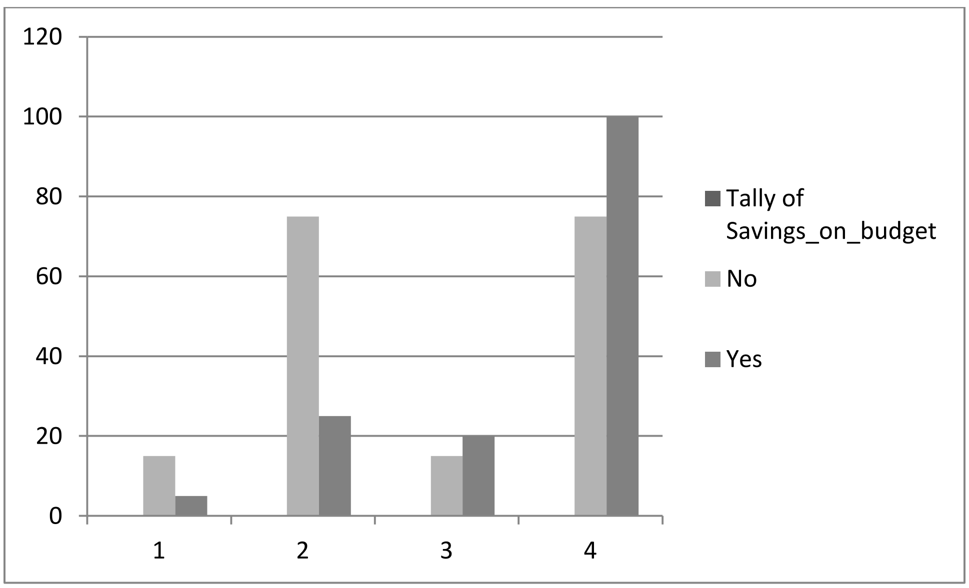

Figure 1.3 Savings on household budget

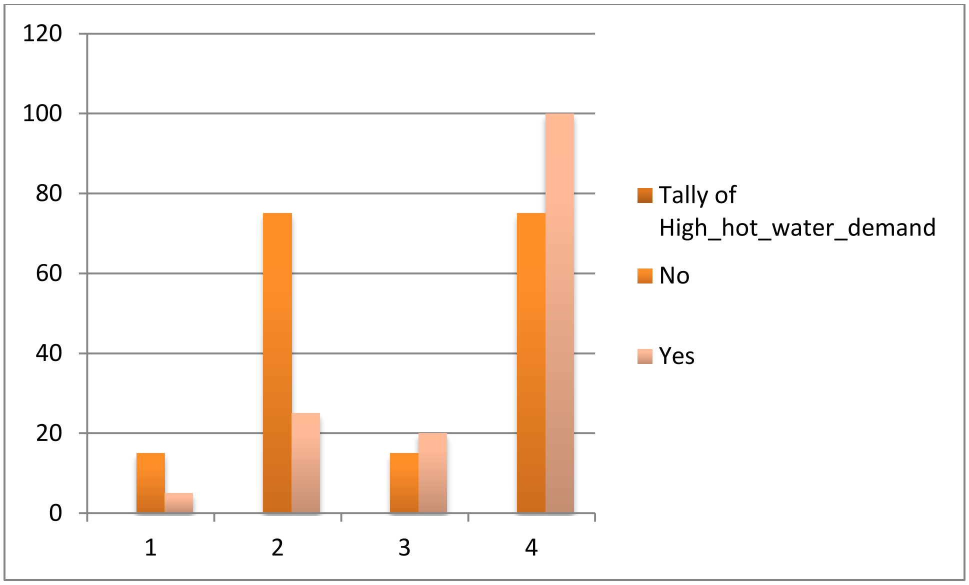

Figure 1.4 Hot water demand

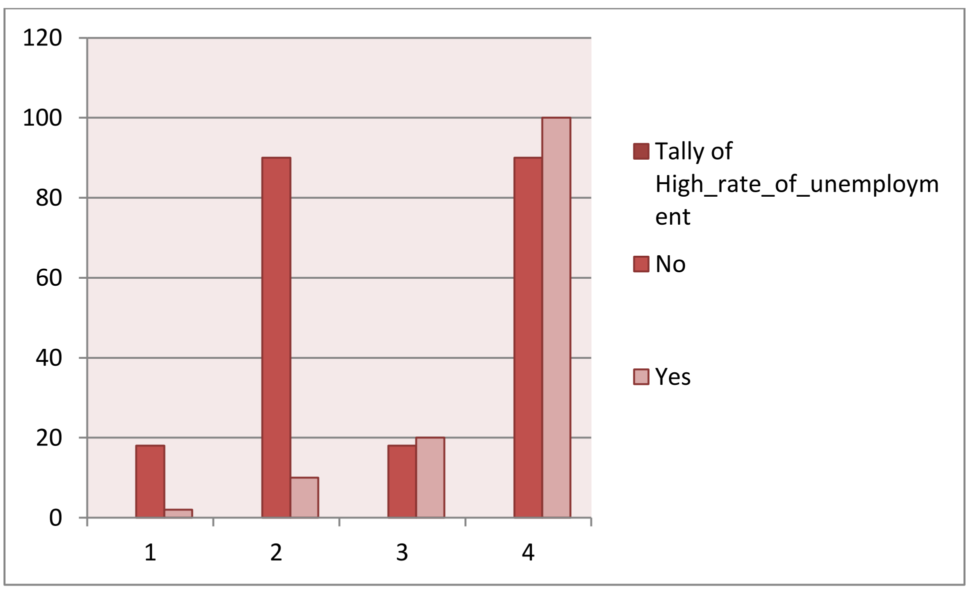

Figure 1.5 High rate of unemployment

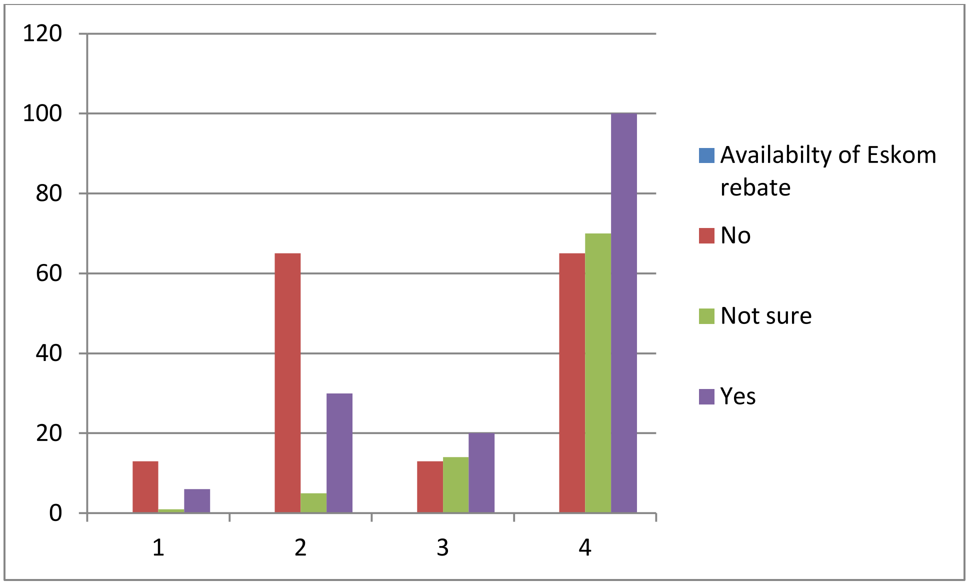

Figure 1.6: Availability of Eskom rebate

Annexure B

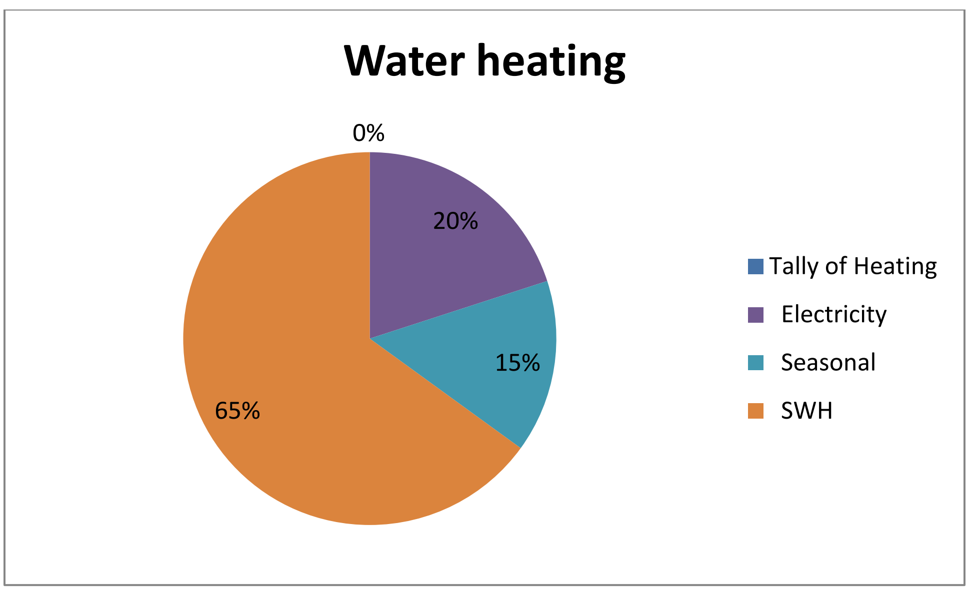

Figure 1.1: Fuel used for heating water

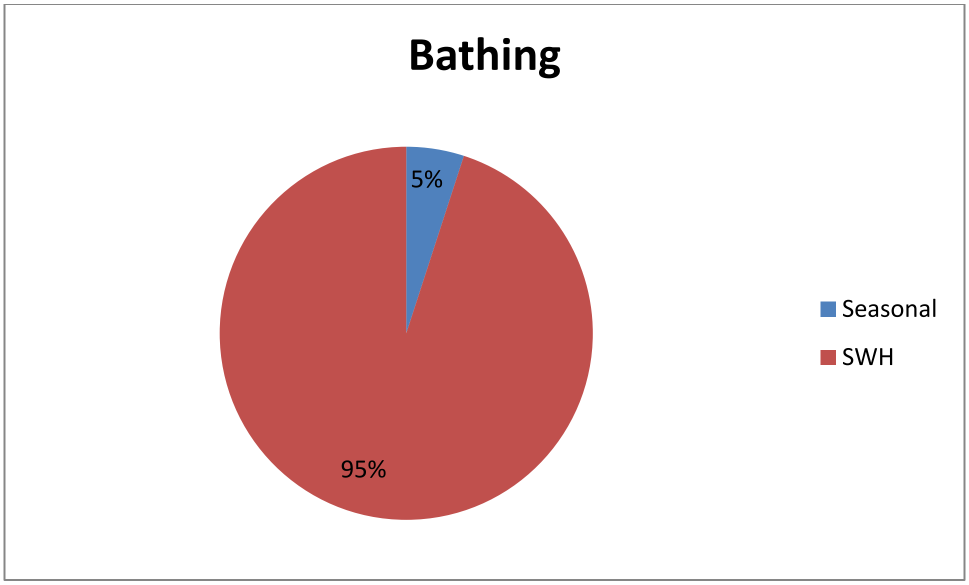

Figure 1.2: Fuel used for bathing

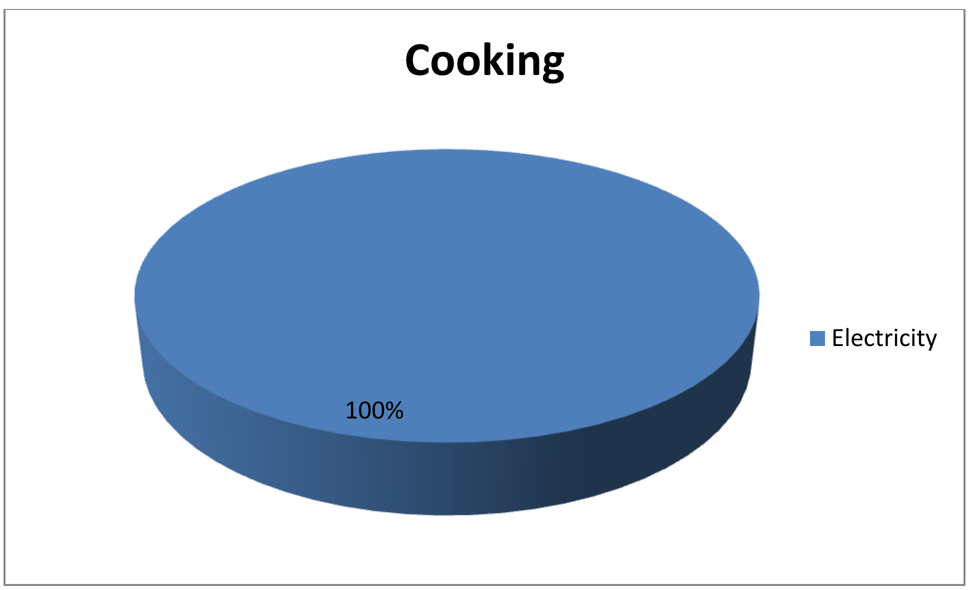

Figure 1.3: Fuel used for cooking

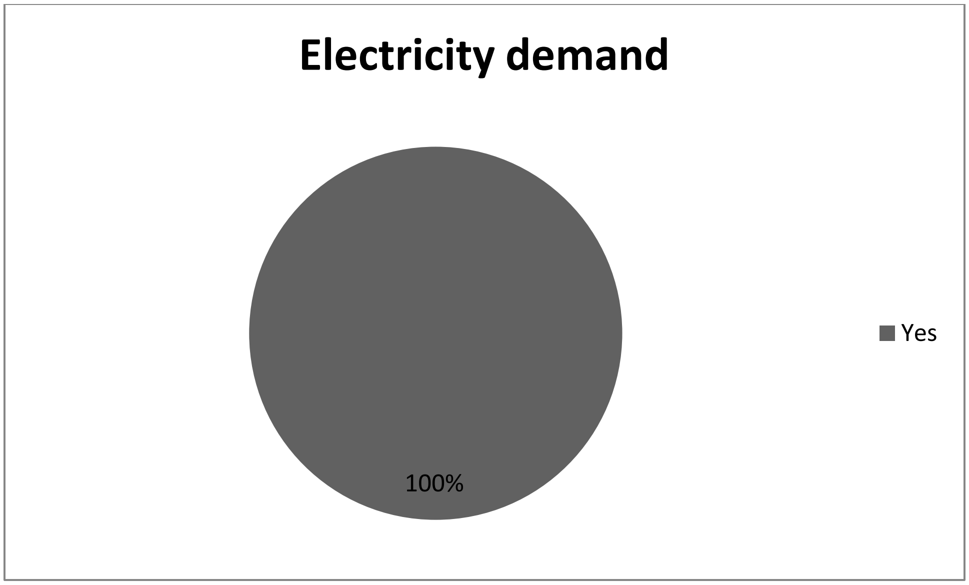

Figure 1.4: Reduction in electricity demand

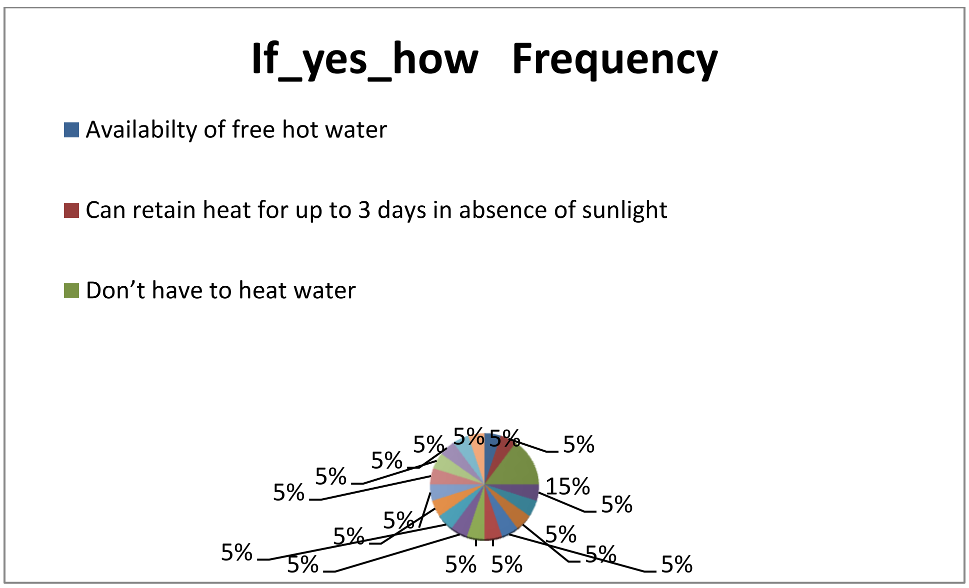

Figure 1.5: If yes how?

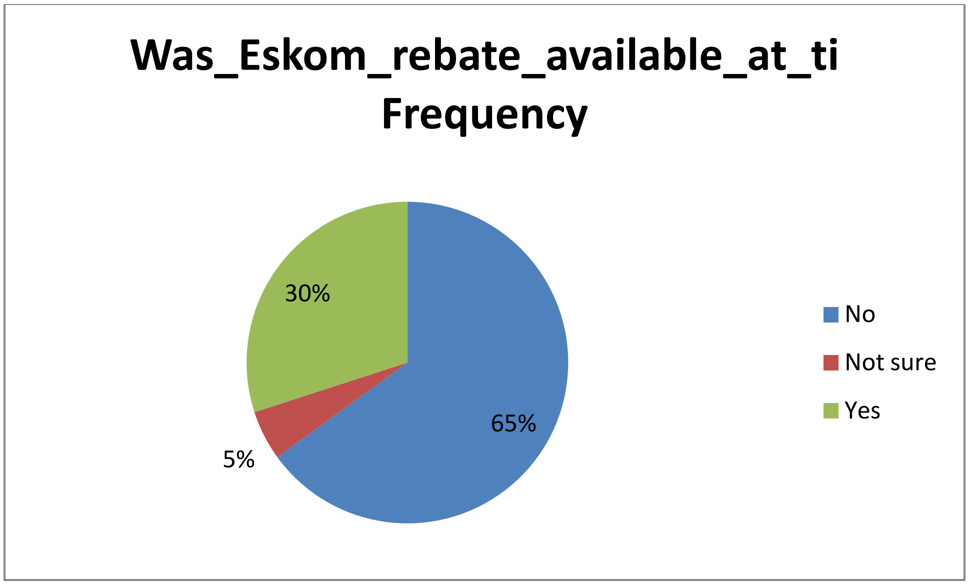

Figure 1.6: Availability of Eskom Rebate

Annexure C

Table 1.1: Frequency table of respondents in the study area

Value	Frequency	Percentage	Cumulative	Cumulative %
Female	16	80	16	80
Male	4	20	20	100

Table 1.2: Affordability of Solar Water Heaters

Value	Frequency	Percentage	Cumulative	Cumulative %
It's cheaper than electricity geyser	1	5.3	1	5.3
No	2	10.5	3	15.8
Yes	15	78.9	18	94.7
You buy it once and there are no electricity rates	1	5.3	19	100

Table 1.3: Do Solar Water Heaters generate household savings?

Value	Frequency	Percentage	Cumulative	Cumulative %
Moderate	9	50	9	50
Very little	2	11.1	11	61.1
Very little in winter and very much in summer	1	5.6	12	66.7
Very much	6	33.3	18	100

Table 1.4: Do SWHs provide a reliable source of power?

Value	Frequency	Percentage	Cumulative	Cumulative %
No	1	5	1	5
Yes	19	95	20	100

Achievement of Objectives/Attainment of Outcomes

The objectives of this research are listed in section 2.3. The positive socioeconomic impact presented by the respondents attained the set research objectives for this project. Convincingly within the context of a developing country, the economic and social aspects the objectives of this research aimed to address as a concern were found to be a success from the respondents and researcher's perspective.

The project's developmental objectives aimed sought improved affordability and operational costs of SWHs; introduce innovative and sustainable SWH programmes for energy consumers in the urban sector, while improving reliability of SWH system as a source of power. Economic benefits for the respondents include access to solar energy because of the affordability of SWHs, improved household financial savings, sustainability of SWH technology due to improved reliability as a source of power. The social benefit in terms of the research objectives of this project is reduction of energy demand. The end result of the project was to promote a higher uptake of SWH technology from low to middle income residential sector.

It was the intention and imperative that the barriers and drivers should be verifiably measurable by evaluating and considering the following indicators:

- Affordability of SWHs
- Generation of household income savings
- Reduce energy demand
- Development of financial SWH programmes
- Improved reliability of SWH

With due regard to the measurable performance project indicators; the following summary portrays a true reflection of the literature review and can, therefore, be presented:

Table 3: Indicators of achievement project objective

Indicator	**Target**	**Achieved**
Affordability	25% average	Household energy expenditure

	annual increase until 2012	is more than 10% of household income
Generation of household income savings	Non set	Per household, +-R625 of annual savings on energy expenditure can be achieved
Energy demand	Measured by performance; reliability of the individual SWH system and 23 % of SWH in 10 000 GWh RE target set	Reduction up to 70% per household
Development of financial SWH programmes	Non set	Access of about 85 % electricity by 2012, with “Go Green Initiatives”
Improved reliability of SWH	None set	Measured by household use of fossil fuel reduction

These project indicators demonstrate the how the research objectives were addressed in terms of establishing the potential for SWHs in urban development.

6. RESEARCH FINDINGS AND DISCUSSION

All the twenty survey questionnaires were answered and analyzed. All responses from questionnaires were tallied into an excel spreadsheet. The data collected answered the questions which the research aimed to investigate. The participants in Buffer Strip seemed to know how SWHs differ from electrical geysers. The respondent's perceptions were articulate in terms of how SWHs contribute to their livelihoods. In this project, most participants confirmed that it was affordable to purchase and install SWH. Participants revealed that the benefits of using SWH technology outweigh the challenges faced.

All these benefits proved the following statement made by Pretorius and van Rooyen, (2013) to be true; that "the implementation of solar geyser does not eliminate the use of electricity; but reduces the usage of a conventional geyser significantly as the normal geyser switches on when water does not reach the required temperature". This in addition supports the notion by Chang *et al*. (2011); that high initial costs would be the hurdle to the market expansion.

Even though the sub-foci did not cover the issue of maintenance of SWHs; but participants were very much concerned about the eventualities and the fate of this solar technology. For this project; participants mentioned that no provision was made by government to assist them with maintenance requirements. It was mentioned that once dysfunctional, liability lies with the end user. From observation in Buffer Strip; maintenance due to technical defect does not hinder nor discourage the users from the continued use of SWH technology. Research conducted illustrates that under normal circumstances SWH does not require any maintenance costs (Chang *et al*., 2011).

Out of the twenty household participants; only one highlighted that the house does not have electricity at all, meaning that this particular household heavily relies on SWH. This can be attributed to the fact that some SWHs have high heat retention capacity than others.

A group of 30% of the participants thought there was a subsidy on purchase and installation of solar geysers. In South Africa, receiving a subsidy is part of the Eskom DSM which offers incentives and introduces to energy consumers alternative ways of reducing electricity demand by switching to solar geyser. This SWH programme provides a rebate to households when installing a solar geyser (Van Rooyen, 2013). 65 % of the participants, who indicated that there was no subsidy on purchase of SWHs, still agreed that SWH costs are far less than electric geyser costs.

This means that if Eskom can introduce more SWHs in residential urban households, this could reduce increasing energy consumption in the residential sector (Rankin & van Eldik, 2008) and may encourage as many South African to move away from electric geyser (Chang *et al*., 2011). In contrary (Chang *et al*., 2011) indicated that current subsidy programs are not enough to facilitate diffusion. Alternative financing mechanisms such as low interest loans for the purchase of SWHs seem to form the basis of this reasoning. Chang *et al*. (2011) has a different opinion that subsidies shorten payback period, which attracts investment and increase the likelihood of adoption.

75 % mentioned that they were attracted to the use of SWHs mainly to save electricity costs. Research shows that the need to reduce electricity demand, energy production and reduced electricity supply leads to energy efficiency. In spite of many South African initiatives Winkler *et al*., (2006) as cited by Chang *et al*., 2011, predicts that the future energy demand will continue to increase until it doubles by 2050. The situation of the increasing energy demand has weakened Eskom's capacity to produce electricity and is it is struggling to keep up with the peak demand (Chang *et al*., 2011).

7. CONCLUSION

Conclusions drawn from the results of the study are as follows:

The current research has identified and evaluated the major barriers limiting urban development; which in turn influence SWH potential. Buffer Strip residential area has demonstrated how the potential for SWH systems has supported urban development in South Africa by improving the economic and social wellbeing of the residents. Findings from the data collected; including the case study projects i.e. Kuyasa and Zanemvula showed that; indeed SWHs improve social and economic livelihoods of the ordinary people. Women contributed the most in this research study and were much conversant about how SWHs have improved the lives of the many in the Buffer Strip. This means that urban development has impacted positively to be recognized by ordinary people in which SWHs are implemented.

This participatory role in women was appreciated by the researcher and must be promoted as they are mostly the critical source of information at a household level. It cannot be underestimated that the impact and potential for SWHs in urban development play a role in poverty alleviation and will continue to increase. This is because participants credited the optimum use of the SWH technology. In addition, responses represent acknowledgment of the positive impact of SWH system at a household level; coupled with financial savings with varying degrees of satisfaction. In the case study projects analyzed and the research study conducted; energy efficiency holds promise for the upliftment and empowerment of the ordinary citizens of the South African urban sector.

Electricity grid energy savings were identified to be another important factor leading to the wide use of SWHs. All these socio-economic aspects significantly contribute to poverty reduction and therefore promote the concept of sustainable development. From the findings of the research study; government must optimally distribute SWHs and provide more subsidies to minimize reliance on conventional electricity; reduce reliance on fossil fuels in order to combat the effects of climate change. However, this cannot be achieved without consumer awareness (supporting education and information programs) and economic considerations (financial incentives cost of electricity, capital costs, income and expenditure) and technical support with focus being more on training program and quality assurance (Chang *et al*., 2011). Rennkamp (2012) attributes the need for technical support with few skilled technicians whom after being trained in the project find high paid opportunities elsewhere.

The barriers identified in literature review create a platform to better integrate the design and implementation of SWH industry into the residential urban development. The study revealed that presently; electric geyser remains the main source of heated water; but the growing energy demand of SWHs in urban areas creates chances for massive installation. This potential stemming from diffusion of SWHs at household level will surely improve and sustain the extent of urban development. This confidence and positive attitude demonstrated by respondents in Buffer Strip creates a platform for South African to promote additional programmes that will support diffusion of solar energy.

Recommendations:

A summary of issues that are of relevance in addressing the issue of SWHs in developing countries; include the use of solar in developing countries, policy development and improvement that attract investment and development of RE sector (Devabhaktuni, 2013). Government should intervene by addressing the issue of maintenance and research should be subsequently conducted. In my opinion; if ignored this could negatively affect the current potential for SWHs in future which is aimed to support urban development. Among the factors mentioned by (Chang *et al*., 2011) dissemination of SWHs is also determined by technical support (training program, quality assurance and standards).

The total demand of residential SWH technology as the water heating infrastructure far exceeds that of hot water. It is unfortunate that there has been very little practical research that can guide rational decision-making by consumers, regulators and legislators. However, one cannot dispute the fact that urban development has positively influenced the potential for SWHs in Buffer Strip area, even though government still needs to target more areas by attracting the use of energy efficient SWHs in urban development. This is evident from the wide use of SWHs in the area. Energy sector should be afforded an opportunity to continue to improve and sustain urban livelihoods beyond what is happening now.

It is clear that SWHs have demonstrated tremendous potential in reducing the level of GHG emissions; as they are rapidly becoming an integral part of worldwide measures in combating the effects of climate change (Chang *et al*., 2011). Without establishing the level of SWHs in influencing the potential for urban development; it would be impossible to provide informed perspectives of the level of urban development.

However, poor technical designs were mentioned as a concern on additions. These include leakage of water which causes an overflow from the SWH bucket to poor design. SWH equipment should be installed with a detector to detect the rate of water flowing in. Variability in heat retention by SWH system was mentioned by some respondents. All the concerns raised during the research study should be incorporated to inform decision making by South African government; if urban development aims to improve the potential for SWH technology. Respondents raised that government must monitor the success of implementation of SWHs as they become nuisance once dysfunctional. It was also mentioned that the manufacturers installing the SWHs cannot be traceable when this solar technology is no longer operational.

It is recommended that water heating infrastructure needs to be retrofitted to sustain the reliability of SWHs as the source power. At this stage a collective support from South African government, NGOs and household energy users in urban areas need to follow in China’s footsteps by focusing on the cheaper operational costs of adopting SWH technology rather than being discouraged by high capital costs. By doing so; the positive findings of this research will gradually be achieved through sustainable urban development which will support the present potential for SWHs in future. It has been discovered that SWHs contribute positively to the alleviation of energy poverty through providing a constant source of heated water (Wlokas, 2011).

7. REFERENCES

Andrade Silver, F.I & Guerra, S.M.G. (2009). Analysis of the energy intensity evolution in the Brazilian industrial sector-1995-2005. *Renewable and Sustainable Energy Reviews*, 13(9), 1131-1139.

Arora, A.J. & Arora, P.R. (2013). Use Solar Heat for Prosperity, Healthy and Pollution Free Life. International Journal of Scientific and Research Publications, 3(10), 1-6.

Baloyi, M. (2011). Solar water drive: steams ahead. www.gcis.gov.za/sites/default/files/docs/resourcecentre/newsletters/features.pdf.

Banks, N. & Schaffler, R. (2006). *The Potential Contribution of Renewable Energy in South Africa* (2nd Ed.). RAPS Consulting & Nano Energy. Johannesburg.

Bosselaar, L. *et al*. (2004). Integration of Solar Water Heating into Residential Buildings: International Practice and Perspectives in China: Moving towards closer integration with the housing industry. www.aee-intec.at/0uploads/dateien254.pdf.

Brazeau, R.H. & Edwards, M.A. (n.d.). A Review of the Sustainability of Residential Hot Water Infrastructure: Public Health, Environmental Impacts and Consumer Drivers. *Journal of Green Building*, 6(4), 77-95.

Bredekamp, A.J., Uken, E.A. & Borrill, L. (2006). Standby power consumption of domestic appliances in South Africa. Domestic use of energy conference. www.myprius.co.za/D04%2010%20-%20%20Bredekamp%20A.pdf.

Bird, D.K. (2009). The use of questionnaires for acquiring information on public perception of natural hazards and risk mitigation-a review of current knowledge and practice. *Natural Hazards and Earth System Sciences*, 9, 1307-1325.

Catherine, Q., Wheeler, J., Wilkinson, R. & de Jager, G. (2012). Hot water usage profiling to improve geyser efficiency. *Journal of Energy in Southern Africa*, 23(1), 39-45.

Chang, K.C., Lin, W.M., Ross, G. & Chung, K.M. (2011). Dissemination of solar water heaters in South Africa. *Journal of Energy in Southern Africa*, 22(3), 1-7.

Chaudhari, S. & Parmar, N. & Panchal, H.N. (2013). A Critical Review on Solar Water Heater. *International Journal of Advanced Engineering Technology*, 1V (11), 50-52.

Chavan *et al*. (2013). Assessing the Awareness of Government Subsidy for Solar Water Heaters among the people of Mumbai (India). *American International Journal of Research in Humanities, Arts and Social Sciences*, 2(2), 145-148.

Davis*, S*., Cohen, C., Hughes, A., Durbach, I. & Nyatsaza, K.. *(*2010). Measuring the rebound effect of energy efficiency initiatives for the future: A South African case study. Energy Research Centre. University of Cape Town.

Davis, S, Prier, M., Cohen, B., Hughes, A., Durbach & Nyatsaza, K. (2011). Measuring the rebound effect of energy efficiency initiatives for the future: A South African case study. Water heating in the middle to high income households. Energy Research Centre. University of Cape Town.

Department of Energy (DoE) (2013).A Survey of Energy Related and Behaviour and Perceptions in South Africa. The Residential Sector

Department of Environmental Affairs and Tourism (DEAT) (2005). Fourteenth Session of the United Nations Commission on Sustainable Development. South Africa. www.un.org/esa/agenda21/natlinfo/countr/safrica/energy.pdf.

Department of Minerals and Energy (DME) (2004). *White Paper on Renewable Energy Policy of the Republic of South Africa*. Pretoria: DME.

Devabhaktuni, V. *et.al*. (2013). Solar Energy: Trends and enabling Technologies. *Renewable and Sustainable Energy Reviews*, 19, 555-564.

Department of Science and Technology (DST) (2013). Solar Energy Technology Roadmap. Pretoria: DST.

Du Toit, H.J. (2010). *A value chain analysis of the solar water heater industry in the Western Cape: Investigating opportunities for local economic development, poverty alleviation and energy conservation*, unpublished Thesis University of Stellenbosch.

Edkins, M., Marquard, A. & Winkler, H. (2010). South Africa's renewable energy policy roadmaps. www.erc.uct.ac.za/Research/publications/10Edkinesetal-Solar_and_wind_policies.pdf.

EThekwini Municipality EThekwini Municipality Integrated Development Plan (2012-2017). Management of EThekwini Low Cost Solar Water Heating Program: Energy Office. http://www.durban.gov.za.

EThekwini Municipality (2014). Journey Towards Sustainability EThekwini Municipality. Durban's moves towards energy sustainability.

Hagos, [1, 2], Gebremedhin, [1] & Zethraeus [1](2014). Solar Water Heating as a Potential Source for Inland Norway Energy Mix. *Journal of Renewable Energy*, 3, 1-11.

Holm, D. (2005). Market Survey of Solar Water Heating in South Africa for Energy Development Corporation (EDC) of the Central Energy Fund (CEF). www.cef.org.za/solar_market_survey.pdf.

Gastli, A. & Charabi, Y. (2011). Solar Water Heating Initiative in Oman Energy Saving. Renewable and Sustainable Energy Reviews, 15, 1851-1856.

Getchell, M., Meuse, P., O'Casey, P. & Sigmon, A. (2012). Solar Water Heating in Oregon's Residential Sector: The Current Landscape. Oregon State University. http://oregonstate.edu/opal/sites/default/files/solar_water_heating_brief_001_1.pdf.

Harris, L.R. & Brown, G.T.L. (2010). Mixing interview and questionnaire methods: Practical problems in aligning data. *Practical Assessment, Research and Evaluation*, 15 (1), 1-19.

Haselip, J., Nygaard, I., Hansen U. & Ackom, E. (2011). *Diffusion of renewable energy technologies: case studies of enabling frameworks in developing frameworks*. Technology Transfer Perspectives Series, UNEP, Riso Centre, Denmark.

Holm, D. (2005). Market Survey of Solar Water Heating in South Africa for Energy Development Corporation (EDC) of the Central Energy Fund (CEF). www.cef.org.za/ solar_market_survey.pdf.

Hudon, K., Merrigan, T., Burch, J. & Maguire, J. (2012). *Low-cost Solar Water Heating Research and Development Roadmap*. (Technical Report No.5500-54793). Colorado: National Renewable Energy Laboratory.

Inglesi-Lotz, R. & Blignaut, J.N. (2011). Estimating the Price Elasticity of Demand for Electricity by Sector in South Africa. *SAJEMS NS*, 14(4), 449-465.

Jacobs, H.E. (2008).Residential Water Information Management. *Peer Reviewed Article*, 10(3), 1-12.

Johnson, A. (2007). Domestic Solar Water Heater for Developing Countries: Design for Sustainable Communities. http://energy.lbl.gov/staff/gadgil/docs/2007/solar-water-heater-rpt.pdf.

Letts *et al*., (2007). Guidelines for Critical Review Form. Qualitative Studies. Qualitative Review Form Guidelines. http://www.srs-mcmaster.ca/.

Khan, S.I. & Islam, A. (2011). Performance Analysis of Solar Water Heater. *Smart Grid and Renewable Energy*, 2, 396-398.

Liu, L. & Liu, J. (2013). Why is China the World's Leader of Solar Water Heater Production and Consumption? *American Journal of Environmental Science*, 9 (2), 182-187.

Maree, K. (2012). *First Steps in Research*. Pretoria: Van Schaick.

Meyer, J.P. (2000). A review of domestic hot-water consumption in South Africa. *R & D Journal*, 16(3), 55-61.

Muhammad-Sukki, F., RamirezIniguez, R., McMeekin, S.G., Stewart, B.G., & Clive, B. (n.d.). Solar Concentrators. *International Journal of Applied Sciences*, 1(1), 1-15.

National Development Plan (2011). www.npconline.co.za/.

Nieuwenhuis, J. (2007). Qualitative Research Designs and Data Gathering Techniques. In: K. Maree (Eds.), *First Steps in Research* (pp.70-97). Pretoria: Van Schaik.

Nyantsaza, K.S. Davis, S.J., Merven, B. & Cohen, B. (n.d.). Modelling the Impact of Energy Efficiency Initiatives in the South African Residential Sector. University of Cape town. South Africa. http://active.cput.ac.za/energy/past_papers/DUE/2010/PDF/Paper%20-%20K%20Nyatsanza.pdf.

Odeku, K.O. (2012). An analysis of Renewable Energy Policy and Law Promoting Socio-economic and Sustainable Development in South Africa. *Journal of Human Ecology*, 40(1), 53-62.

Odigwe, I.A. *et al* (2013). A microcontroller-based Active Solar Water Heating System for Domestic Applications. *International Journal of Renewable Energy Research*, 3 (4), 837-845.

Ogie[1], N.S., Oghogho[2], I., Jesumirewhe[3], J. (2013). Design and construction of a solar water heater based on the Thermosyphon principle. *Journals of Fundamentals of Renewable Energy and Applications*, 3, 1-8.

Ozdemir, E.D., Marathe, S.D., Tomaschek, J., Dobbins, A. & Eltrop, L. (2012). Economic and environmental analysis of solar water heater utilization in Gauteng Province, South Africa. *Journal of Energy in Southern Africa*, 23(2), 1-18.

Patel[1], K., Patel[2], K. & Patel[3], J. (2012). Review of Solar Water Heating Systems. *International Journal of Advanced Engineering Technology*, 3(4), 146-149.

Pillai, I.R. & Banerjee, R. (2007). Methodology for estimation of potential for solar water heating in a target area. *Solar Energy*, 81, 162-172.

Prasad, G. (2007). Work Package 2-Historical and recent attitudes of stakeholders. Case 19: Solar water heaters (SWH). Energy Research Center. University of Cape Town. www.esteem-tool.eu/fileadmin/esteem-tool/docs/CASE_19_def.pdf.

Pretorius, A. & van Rooyen, S. (2013). Investigating the Financial Implications of Alternative Water Heating Systems. *International Journal of Business & Economics Research Journal*, 12(7), 781-792. University of Cape Town. www.hinfo.humaninfo.ro/gsdl/genus/documents/s20486en/s20486en.pdf.

Qase, N. & Anneckie, W. (1999). Energy provision for the Urban Poor: South African country case study. Energy and Development Research Centre.

Rankin, R. & van Eldik, M. (2008). An investigation into the energy savings and economic viability of heat pump water heaters applied in the residential and commercial sectors-A comparison with solar water heating systems. North West University (Potchefstroom Campus). www.powersaving.co.za/.

Rennkamp, B. (2012). South African Approaches to MRV of Mitigation Actions: The Case of Installing Solar Water Heaters. Energy Research Centre. www.erc.uct.ac.za/.

Satam, A.A. (2013). A Descriptive Study of the Constructional Features of Evacuated Tube Solar Water Heating System. *IOSR Journal of Mechanical and Civil Engineering*, 3, 36-41.

Van Rooyen, S. (2013). Investigating the Implications Financial Implications Of Alternative Water Heating Systems. *International Business & Economics Research Journal*, 12(7), 781-792.

Visagie, E. & Prasad, G. (2006). Renewable energy technologies for poverty alleviation.

Welman, C., Kruger, F., & Mitchell, B. (2012). *Research Methodology*. Cape Town: Oxford University Press.

Wlokas, H.L. & Ellis, C. (n.d.). Local employment through the low pressure solar water heater roll-out in South Africa. Energy Research Centre: Cape Town.

Wlokas, H.L. (2011). What contribution does the installation of solar water heaters make towards the alleviation of energy poverty in South Africa? *Journal of Energy in Southern Africa*, 22(20), 27-39.

Winkler, H., Spalding-fecher, R., Tyani, L. & Matibe, K. (2002). Cost Benefit Analysis of Energy Efficiency in Urban-Low Cost Housing. *Development Southern African*, 19(5), 593-613.

Winkler, H. (2005). Renewable energy policy in South Africa: policy options for renewable electricity. *Energy Policy*, 33, 27-38.

Ziuku[1], S. & Meyer[2], E.L. (2012). Mitigating Climate Change through Renewable Energy and Energy Efficiency in the Residential Sector in South Africa. *International Journal of Renewable Energy Technology Research*, 2(1), 33-43.

Nelson Mandela Metropolitan University

for tomorrow

Dear respondents

This study forms part of the social and economic development research at the Nelson Mandela Metropolitan University in the field of Development Studies. The research focuses on the relationship between Potential for Solar Water Heaters and urban development.

The purpose of this questionnaire is to determine Potential for Social Solar Water Heaters, looking at the current scope of solar waters heaters installed in Buffer Strip in Msunduzi Local Municipality within Umgungundlovu District Municipality in the Kwa-Zulu Natal Province, South Africa. The information provided will be treated confidentially hence no name is required and the analysis will be group referenced.

Your opinion is valuable for the research and it will be greatly appreciated if you could find time to complete the questionnaire. It will take approximately 10 minutes to complete. There are no right or wrong answers. You are requested to fill in the questionnaire as freely and honestly as possible. You may stop participating at any given time. Findings of this research will be used to determine if there is potential for solar water heaters in Buffer Strip in future.

Thank you for your anticipated cooperation.

Yours sincerely,
Student: Thobisa Dlepu

If you have any questions, please do not hesitate to contact me at 079 297 6447 or email me at s213515385@nmmu.ac.za

I hereby confirm that I am taking part in this study by my own free will	**Signature**
Yes	
No	

Questionnaire
Mark the appropriate block with an X
Section A: Demographic details (household head)

Gender	Male	1
	Female	2

Age	20-30	1
	31-40	2
	41-50	3
	51-60	4
	61-70	5
	71-80	6

	English	1

Language	Zulu	2
	Xhosa	3
	Sotho	4
	Afrikaans	5

Education	No Formal Education	1
	Primary School	2
	High School	3
	College	4
	University	5

Which option do you think best attracted the use of solar geyser in your home?

	Yes	**No**
Savings on household electricity costs		
Savings on household budget		
Cheap installation of solar geyser		
High hot water demand in your home		
High rate of unemployment in your home		

Section B: Household

What is your household size?		**Persons**

Total number of people	1. Males	
	2. Females	

How many dependents do you have?		**Persons**

How many people in the household are working?		**persons**

Occupation of the household head	Pensioner	**1**
	Employed	**2**
	Unemployed	**3**
	Business	**4**
	Other(specify)	**5**

Which category best describes your monthly income	
R0 – R 4,999	
R5,000 – R 9,999	
R10,000– R 15’999	
R16,000 – R 24,999	
R18,000– R29,999	
R 30,000 – R 39,999	
R 40,000 – R 49,999	

R50,000 +	

Household: Monthly Expenses	
Expenses	**Rand (R)**
School fees	
Transportation / fuel	
Food	
Electricity	
Water	
Clothes	
Entertainment	
Savings (funeral, society, banks)	
Other:	

Monthly household expenditure (Rand, nominal values)	
R0 – R 399	
R400 – R 799	
R800 – R 1199	
R1200 – R 1799	
R1800 – R 2499	
R 2500 – R 4999	
R 5000 – R 9999	
R10 000 upwards	

Which fuel do you use for your household activities?		
Heating water	Solar	Electricity
Bathing	Solar	Electricity
Cooking	Solar	Electricity

Section C: Social grants

1. What type of grant do you receive in your household?

	Yes	**No**
Grant for older persons		
Child support grant		
Disability grant		
War veteran's grant		
Child grants: Foster child grant		
Care dependency grant		
Grant-in-aid		

2. Are the grants you receive sufficient to cover your household needs?

Yes	No

3. What is the role that social grant (s) you receive impact on your household consumption?

High	Moderate	Low

Please explain why:
…………………………………………………………………………………
…………………………………………………………………………………
…………………………………………………………………………………
…………………………………………………………………………………

Section D: Poverty status

1.

Do you consider your household to be poor? If yes please indicate:	**Yes**	**No**
Very poor		
Averagely poor		
Not poor		

2. If yes, what do you think is the cause of the situation?

	Yes	**No**
Availability of solar geyser rebate		
Prices are too high		
Social grants are too low		
Economic constraints		
High rate of unemployment		
Lack of access to adequate resources		
Lack of education		
Lack of information		

Section E: Energy efficiency of solar water heaters in your home

1.

Are solar water heaters an affordable technology?	
Yes	No

If yes, why?
……………………………………………………………………………………
…………………………………………………………………………………

2.

Do solar water heaters generate household savings?	**Yes**	**No**
Very little		
Moderate		
Very much		

3. Do solar water heaters reduce the demand for electricity in your home?

Yes	No

If yes, please explain.
………
……………………………………………………………………………….................................

4. Was Eskom rebate available at the time of purchasing your solar geyser?

Yes	
No	

5. Do solar waters heaters provide a reliable source of power?

Yes	
No	

If yes, how?
………
……………………………………………………………………………….................................

1. **Additional information?**
   ....
   ....
   ....
   ....
   ....
   ....
   ....
   ....
   ....
   ....
   ....

Thank you for your participation!