Mitigating exclusionary greening of South African cities through participation of indigent households in renewable energy: The case of Galeshewe settlement in Sol Plaatje Municipality, South Africa

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Declaration

I declare that this research report is my own unaided work. It is being submitted for the Degree of Masters of Architecture in the Field of Sustainable and Energy Efficient Cities to the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination to any other University.

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Signature Date

Abstract

Based on the Sol Plaatje Municipality case study, this study focuses on how an innovative municipal business and funding approach could serve as a tool for transitioning from fossil fuels to renewable energy (solar) for the benefit of both indigent households and the municipality. Primary data from the municipality and indigent households in Galeshewe settlement indicates that in its current form, the 50kWh free basic electricity that indigent households receive monthly from the municipality is insufficient for their basic energy needs, while purchasing additional electricity is becoming increasingly unaffordable. This results in suppressed demand for the households and ongoing risk to the municipality due to escalating costs.

In mitigation of the two fundamental challenges, findings from primary and secondary data have guided the study to the Renewable Energy for Low Income Earners (RELIE) model. The Equitable Share Grant and Integrated National Electrification Programme Grant (as currently allocated to municipalities by National Treasury and the Department of Energy for free basic electricity and electricity infrastructure provision for low income households) are highlighted as the initial funding channels under the proposed model based on a backcasting approach. Municipal energy plans and policies as well as integrated human settlements' spatial plans also emerge as critical tools for transitioning to inclusionary RE. Other funding sources in the RELIE model include existing government funds such as the Green Fund and the Central Energy Fund from the Department of Environmental Affairs, as well as supplementary funds from relevant agencies such as climate funding entities and philanthropic socially responsive investments.

The model also envisages end-user contribution through affordable payments for service. In conclusion, the study recommends that the RELIE model findings could be adapted for other municipalities in South Africa faced with the escalating indigent household energy crisis.

Key Words: backcasting, free basic electricity, business model, indigent households, renewable energy, photovoltaic (PV), suppressed demand

Dedication

I dedicate this research report to my husband John,
and our kids Oreratile, Mabotsa and Luzuko.

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List of Abbreviations, Acronyms and Units of Measure

AC	Alternating Current
AfDB	African Development Bank
Amp	Ampere
CBD	Central business district
CDM	Clean Development Mechanism
CEF	Central Energy Fund
CER	Certified Emission Reduction
CIF	Climate Investment Fund
COGTA	Department of Cooperative Governance and Traditional Affairs
CSIR	Council for Scientific and Industrial Research
DBSA	Development Bank of South Africa
DC	Direct Current
DDG	Decentralised Distribution Generation
DEA-RSA	Department of Environmental Affairs :Republic of South Africa
DME-RSA	Department of Minerals and Energy: Republic of South Africa
DoE-RSA	Department of Energy: Republic of South Africa
DTI	Department of Trade and Industry
EE	Energy efficiency
EPCs	Energy Performance Contracts
ERC	Energy Research Centre
ESETA	Energy Sector Education and Training Authority
ESG	Equitable Share Grant
ESMAP	Energy Sector Management Assistance Programme
EU	European Union
FBAE	Free Basic Alternative Energy
FBE	Free Basic Electricity

FiT	Feed-in tariff
GCF	Green Climate Fund
GHG	Greenhouse gas
GIZ	German Society for International Cooperation
GTZ	German Technical Corporation
ICLEI	International Council for Local Environment Initiatives
IDC	Industrial Development Corporation
IDPs	Integrated Development Plans
INEP	Integrated National Electrification Programme
kWh	Kilowatt-hour
kWp	Kilowatt-peak
LED	Light-emitting diode
MDG	Millennium Development Goals
MFI	Microfinance Institutions
MTREF	Medium-Term Revenue and Expenditure Framework
MWh	Megawatt-hour
NAMA	Nationally Appropriate Mitigation Action
NDP	National Development Plan
NERSA	National Energy Regulator of South Africa
NGO	Non-government organisation
NPC	National Planning Commission
NPV	Net Present Value
OECD	Organisation for Economic Co-operation and Development
PoA	Programmes of Activities
PPP	Public private partnership
PV	Photovoltaic
RE	Renewable energy
REIPPP	Renewable Energy Independent Power Producers Procurement Programme
RELIE	Renewable Energy for Low Income Earners

ROI	Return-on-investment
RSA	Republic of South Africa,
SACN	South African Cities Network
SARETEC	South African Renewable Energy Technology Centre
SARS	South African Revenue Service
SE4ALL	Sustainable Energy for All
SEEDS	Sarvodaya Economic Enterprise Development Services Guarantee Ltd.
SETA	Sector Education and Training Authority
SLPs	Social Labour Plans
SMMEs	Small, Medium and Micro Enterprises
SPM	Sol Plaatje Municipality
SSEG	Small-Scale Embedded Generators/Generation
Stats SA	Statistics South Africa
SWH	Solar water heaters
TERI	The Energy and Resources Institute
UN-DESA	United Nations Department of Economic and Social Affairs
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
Urban LEDS	Urban Low Emission Development Strategies
USD	United States dollar
VCS	Voluntary Carbon Standard
WHO	World Health Organisation

Chapter 1

Introduction

1.1 Background and context

Over the past decade and a half, South Africa's large urban centres have experienced a tremendous growth in population. South Africa is experiencing continuing urbanisation which is estimated to reach 71.3% by 2030 and nearly 80% by 2050 (COGTA-RSA, 2016). The South African National Development Plan (NDP) noted that about 60% of the South African population lives in urban areas. In line with global trends, the movement of people from the countryside to the cities is expected to continue (NPC-RSA, 2012). This trend indicates that cities will continue to experience increased pressure to provide services under increased costs associated with the provision of such services.

With increasing urbanisation and migration, cities are becoming increasingly dense and congested, and government authorities are faced with a challenge of meeting the basic needs of citizens. The speed and scope of urbanisation have presented challenges to national and local government capacity to provide essential services and infrastructure (UN Habitat, 2015). Given that access to clean and affordable energy is one of the basic human rights, the inability to provide adequate energy services means that human rights are compromised (Makonese et al.: 2006). With the high demand for services due to increasing population, there is also the growing risk that demand is likely to outstrip supply. In addition, indigent households are rendered vulnerable because they cannot afford the escalating cost of electricity. The government is therefore challenged to be at the forefront of mitigating such vulnerability through various financial and non-financial interventions. In addition, cities need to continuously improve their infrastructure and service provision whilst ensuring environmental sustainability. The provision and maintenance of services comes at a cost which municipal budgets alone cannot afford to finance given the ever-increasing population in cities.

Indigent households are the most vulnerable segment of the population in an environment of budgetary limitations and government needs to prioritise its interventions for this segment of society. The government must intervene to ensure that all citizens, particularly indigent households, have access to clean, affordable energy. Inadequacies and gaps in addressing the latter segment of the population would be problematic and may lead to social exclusion, i.e. one group of the population feeling excluded and unable to access quality services to which they are entitled.

1.2 Renewable energy in context

To date, government's efforts to promote the adoption of alternative energy, including renewable energy (RE), cannot go unnoticed. Underpinning the ongoing policy shifts are social, economic and environmental concerns. Greenhouse gas (GHG) emissions in cities are significantly high due to high dependence on fossil fuels, increasing urbanisation as well as high population densities. GHG emissions have negative effects and have a direct bearing on global warming. Cities need to reduce their GHG emissions in various ways, including reduction in the use of electricity from fossil fuels such as coal. Surridge-Talbot (2015) noted that South Africa is among the highest emitters of carbon dioxide in the world, currently ranked twelfth in terms of top emitters *per capita* mainly because more than 80% of South Africa's primary energy is derived from coal which is a fossil fuel. There is therefore an urgent need to reduce fossil fuel dependency and diversify the energy mix and supply, in order to reduce South Africa's carbon footprint whilst ensuring energy security.

The NDP (NPC-RSA, 2012) provides a comprehensive basis for further policy and strategy development in various sectors, including the energy sector where a target has been set to generate 20 000 MWh of renewable energy by 2030, with a provision for a diversified energy market. A series of widespread electricity supply interruptions from Eskom, especially since the 2007-2008 electricity crises, is identified as a trigger towards transitioning from fossil fuel energy to renewable energy (Lawrence, 2013). Deeper rooted reasons have additionally contributed to this necessity. Key among these is a significant cost saving potential through energy

efficiency measures and the imperative to mitigate South Africa's impact on climate change. Effective policy guidelines and strategies are therefore required for South Africa to promote RE and thus contribute effectively to climate change mitigation as well as promote sustainability. It is therefore critical that government, including local authorities, promote the use of RE as one way of reducing carbon emissions. However, this should be done in a way that ensures access to energy for all citizens, especially members of indigent households, and not merely those who are in middle- to high-income households.

Furthermore, RE generation technologies save on water consumption in comparison with coal-fired power plants. The provision of reliable and affordable energy for businesses and the residential markets underpins everyone's quality of life. Moreover, Calitz et al. (2017) have acknowledged the economic and environmental benefits of RE. An independent study by the Council for Scientific and Industrial Research (CSIR) "determined that in the first six months of 2015, wind and solar projects created R4 billion more financial benefits to the country than what these projects cost" (Calitz et al., 2017: 24).

According to Zervos (2015), benefits associated with increased uptake of renewable energy are highlighted towards helping the world achieve a sustainable development milestone. "… for the first time in four decades, the world economy grew without parallel rise in carbon emissions" (Zervos, 2015: 5). There is therefore growing evidence that should government commit to the promotion of RE, economic development spinoffs would increase without an increase in carbon emissions. Zervos (2015) further mentioned the steady growth of solar photovoltaics (PV) which shows significant market penetration and adoption. Roughly USD64 billion was invested in this RE sector in 2014. Although there were such significant efforts and investments in various countries globally and in South Africa, Zervos (2015) argued that growth in renewable energy capacity is below the rate necessary to achieve the Sustainable Energy for All (SE4ALL) goals of doubling the level of RE and providing universal access by 2030. In light of the latter statement being more critical of the success of promotion and uptake of RE to date, it emphasises the need to accelerate the rate of RE adoption through government-driven interventions.

On the other hand, the current reality of Eskom's inability to provide uninterrupted electricity supply has become a huge challenge facing the country as it negatively impacts on the economy and general quality of life of the citizens. The Organisation for Economic Co-operation and Development (OECD, 2012: 18) noted that Eskom's 2008 electricity crisis materialised as a result of substantial increases in electricity consumption without a matching growth in new generation capacity coming on stream. As a result, power rationing and rolling blackouts became necessary in order to protect the network from collapsing.

There are financial risks which face Eskom and municipalities in the wake of accelerated RE uptake. According to MacColl (2015: 1), Eskom's general manager for research, "[e]nergy analysts and economists have warned that as the costs of renewable energy and more efficient battery systems continue to fall, more and more middle-class and wealthy South Africans will realise that a once-off investment in independence from the grid makes financial sense in the face of sharply increasing Eskom tariffs and the inconvenience of load shedding".

If this anticipated shift materialises, cross-subsidisation of indigent households by the middle-class consumers would be negatively affected, thus resulting in escalating shortfalls in Eskom's and municipalities' budgets. This is a reality already intensifying. MacColl (2015: 1) further stated that Eskom is worried about shifting to renewable energy. "It's a worry for us to be totally honest with you … what if everyone said, well, that's it, we're off the grid … Hey, it would be the end of the power company as we know it" (MacColl, 2015: 1). The article concluded by stating that South Africa is at risk of grid defection due to two factors; first, the year-round clear skies, particularly to the north of the country, thus making solar PV with batteries more feasible; and, secondly, due to load shedding and escalating tariffs for grid-supplied electricity. This is a huge risk, not only for Eskom, but for a majority of the municipalities who are highly dependent on revenues from electricity sales. Other systemic implications linked to shifting to RE and feeding electricity into the grid would be reduced revenue from electricity sales: the entire electricity supplier value chain would be negatively affected in the form of job losses at the utility level, from suppliers from the coal industry, as well as related industries such as transportation,

catering, storage of raw material (coal) in instances where leased properties are used for storage amongst others.

Shifting to RE has repercussions for both Eskom and municipalities in the form of unsustainable reduced revenue from electricity sales. Grid defection could be realised by those who can afford it, thus leaving the indigent households without choice but to continue utilising energy from fossil fuels and other sources which are environmentally degrading. As earlier mentioned, even cross-subsidisation of indigent households would be negatively affected as paying consumers would decrease, thus leaving a huge financial burden on government and municipalities to single-handedly finance the provision of energy to the indigent households.

In view of the driving factors reviewed above, government and municipalities have a duty to ensure that there is a conscious shift from high reliance on electricity from fossil fuels to incorporating electricity from RE, especially through solar PV, among other alternative technologies. The government is therefore a critical player in ensuring the necessary shift to RE, particularly solar PV, for the socio-economic and environmental drivers reviewed above. In particular, municipalities would be responsible for making electricity accessible, and especially ensuring affordability, and for the promotion of RE among the indigent household consumers. There is therefore an urgent need to transform cities from fossil energy dependency to RE-based low-carbon cities while also ensuring that inclusivity is enhanced. In addition, municipalities could promote indigent households as ‘prosumers’, that is, producers who are simultaneously producers and consumers of energy (Kicinski, 2013:749). In this way, energy can be accessible for consumptive and productive purposes with a positive contribution to long-term economic development, as well as environmental benefits (Nissing and Von Blottnitz, 2009).

1.3 Energy in context – indigent households

Energy poverty, lack of affordability, exclusion, as well as suppressed demand, continue to undermine energy access by indigent households especially in urban areas. There is a cyclical relationship between the variables mentioned above in that the indigent households continue to be energy-deprived due to lack of affordability, which in turn leads to socio-economic exclusion and escalation in suppressed

demand. For this pattern to be reversed, government has to play a role, with municipalities at the centre of service delivery. Forms of intervention could include innovative funding business models underpinned by pro-indigent household policies and RE-focused urban development models. As substantiated in the subsequent chapters of this study, energy service provision based on RE, in conjunction with pro-indigent household urban models and policies, can help indigent households to access the formal economy thus transforming them into tax-paying as opposed to welfare-absorbing citizenry. Small and medium enterprises are especially sensitive to reliable and affordable energy services and are currently a vital source of employment for the indigent households as prioritised in this study (Keller, 2012: 53; Saghir, 2004).

1.3.1 Energy poverty

Energy poverty is defined as a lack of access to modern energy services, which tends to be a key characteristic of the low income households in developing countries (Vermaak et al., 2008). The Energy and Resources Institute (TERI) (2008: 2) defined energy poverty as “absence of sufficient choice in accessing adequate, affordable, reliable, quality, safe and environmentally benign energy sources to support economic and human development”. The indigent households therefore remain trapped in energy poverty and now face the growing risk of being excluded from the RE space and the benefits linked to clean energy services. Keller (2012: 121) stated that “in the absence of clean energy, many indigent households heat their homes with paraffin heaters or coal and wood fires which have energy poverty entrenching dynamics”. The study further argued that reduction in the usage of these fuels brings immediate and tangible relief to such households.

As alluded to earlier, the government has a major role to play in reversing this trend in order to ensure that energy poverty is redressed and that access to affordable solar energy is guaranteed. The government has the mandate and capacity to influence this shift, especially if the approach is based on a clear strategy and responsive business model. In terms of urban energy infrastructure, significant progress has been made, especially through the Integrated National Electrification Programme (INEP), which has seen 80% of all South African households currently

enjoy grid connection (Jaglin, 2009). Despite this achievement, small and frequent additional purchases of electricity need to be made by many indigent households because the monthly Free Basic Electricity (FBE) subsidy is not sufficient for indigent household operations. This implies a further transportation cost to the point of sale of prepaid energy (Ruiters, 2009).

High transportation costs in whatever form, must be avoided in order to ensure improved and affordable access to clean energy. For example, energy transportation or transmission of electricity in its current form contributes to high electricity costs for which the consumer eventually pays. In an attempt to increase affordability of clean energy access for indigent households, Glemarec (2012) argued for a contrast in prices between energy from fossil fuels and from RE. Energy prices from fossil fuels, such as paraffin, continue to increase annually or sometimes more than once a year, whilst the cost of clean energy is rapidly falling (Glemarec, 2012). As long as the status quo prevails, and in view of perpetual fossil fuel-based energy price increases, energy poverty in developing countries such as South Africa will persist.

There are significant barriers to RE implementation which in turn contribute to energy poverty. These are clearly outlined in the White Paper on Renewable Energy (DME-RSA, 2003) and they need to be effectively addressed if South Africa wants to succeed in transitioning from fossil fuels to RE. Key among these barriers is that many RE technologies remain expensive, on account of higher initial capital costs, compared to conventional energy supplies for bulk energy supply to urban areas or major industries. Secondly, besides high capital investment, implementation of RE technologies may need support for relatively long periods before reaching profitability thresholds. There is also a lack of consumer awareness on the comprehensive range of benefits and opportunities of RE, especially where communities are generally unaware of the long-term benefits of clean energy. In addition, the economic and social system of energy services is currently structured around conventional sources of centralised energy, and especially electricity generation, gas supplies and to some extent, liquid fuel provision. Financial, legal, regulatory and organisational barriers are cited as additional constraints to be overcome in order to scale-up adoption of RE technologies and consolidate related markets. The White Paper (DME-RSA, 2003) further noted that a lack of non-discriminatory open access

to key energy infrastructure such as the national electricity grid, certain liquid fuels and gas infrastructure continue to inhibit implementation of RE.

1.3.2 Energy burden

Indigent households experience a higher 'energy burden' in comparison with urban middle- to high-income households, when one considers the percentage of total household budget spent on energy services. According to Prasad and Ranninger (2003), an average energy burden for indigent households in remote rural villages is about 18%, and after an allocation of 50 kWh of FBE, the energy burden is reduced to about 12% of the total household budget. In addition, Sugrue and Lebelo (2009) emphasised the high-energy burden faced by indigent households as they spend a much greater proportion of their income on fuel than the medium-high income households. For South Africa's indigent households, energy burdens can amount to between 12% and 20% of household income (Sugrue and Lebelo, 2009). As indicated in Table 1.1, the energy burden of an un-electrified rural household is in excess of 22%, whereas the urban indigent households (electrified) have an energy burden of around 12%.

TABLE 1.1: COMPARISON OF ENERGY BURDEN FOR DIFFERENT HOUSEHOLD SEGMENTS

End-Use	Medium–high income		Low income (Urban)		Low income (Rural)	
	Source	**Cost**	**Source**	**Cost**	**Source**	**Cost**
Lighting	kWh	R58	kWh	R20	Candles	R35
Cooking	kWh	R80	kWh/ Paraffin	R120	Paraffin	R90
Space-heating	kWh	R44	Coal	R40	Wood	R10
Space-cooling	kWh	R47	–	–	–	–
Water-heating	kWh	R206	kWh/ Paraffin	R20	Wood	R5
Refrigeration	kWh	R30	–	–	–	–
Dishwasher	kWh	R73	–	–	–	–
Television	kWh	R10	kWh	R7	Car battery	R25
Radio	kWh	R2	kWh	R2	Dry cell	R25
Cell phone charger	kWh	R1	kWh	R1	kWh (ext.)	R20
Total		**R548**		**R209**		**R210**

Monthly income	**R9 167**		**R1 683**		**R948**
Energy burden	**6%**		**12%**		**22%**

Source: (Sugrue and Lebelo, 2009:10)

In one of its survey reports, the Department of Energy (DoE-RSA, 2013: 105) highlighted some profound findings as reported by various households. As an example, an average of 77% of respondents preferred government to intervene in the provision of free energy per month, replace electric geysers with solar water heaters and engage in awareness campaigns towards encouraging consumers to use energy more efficiently. Inherent in the DoE's findings is that electricity has become unaffordable and thus inaccessible to most low-income households.

Government currently provides a range of incentives and rebates towards shifting to RE. These benefit the middle-income category, whilst the indigent households are excluded. Inherent in these incentives is an active role played by such consumers where they enforce the choice to spend on purchasing and installation of a solar PV, for example, and through the Feed-in Tariff (FiT) scheme (where it is implemented by local municipalities) are able to claim revenue based on surplus energy fed onto the grid. Eskom rebates were linked to the installation of solar water heaters (SWHs) where consumers could claim a portion of the total cost of the system, which thus constitutes income back into their pockets. On the other hand, middle income earners use more electricity and need to be encouraged to save so that such saved energy can be availed to the indigent households, at cheaper rates. Also, middle-income earners waste more electricity.

Other government incentives that benefit middle- to high-income earners include a tax allowance linked to the South African Revenue Service (SARS), as well as the proposed National Energy Regulator of South Africa's (NERSA) Small-Scale Embedded Generators (SSEG) initiative (NERSA, 2015). SSEG is a proposed government initiative aimed at promoting RE and economic growth whilst reducing carbon emissions, as those who can afford will be incentivised to produce and feed surplus electricity into the grid and simultaneously claim revenue from the energy distributor, namely Eskom or municipalities. It focuses on a Net-Metering Scheme,

where tariffs associated with exporting electricity are factored towards the determination of the monthly bill.

However, indigent households cannot benefit from the above opportunities as they cannot afford the initial capital cost and therefore have no choices to shift to RE. They remain trapped in energy poverty and thus fully dependent on government's intervention when it materialises.

Currently, the South African government provides grants to subsidise electricity for the indigent households in both urban and rural areas. Grants provided are for free basic electricity (FBE) of 50 kWh to indigent households through an Equitable Share Grant (ESG). Beneficiary households must have a total monthly income of not more than R3 500.00. In addition, the government provides grants to municipalities in support of Free Basic Alternative Energy (FBAE) which targets the indigent households in un-electrified areas (DoE-RSA, 2013). Makonese et al. (2006) and Ruiters (2009) argued that the current 50 kWh provided for the indigent households as part of FBE is insufficient towards effective mitigation of energy poverty among such households.

The DME-RSA (2003), as quoted in Makonese et al. (2006), has given an example of utilisation of a small refrigerator for 30 days consuming 49 kWh, in essence consuming 100% of its allocated FBE. On average, an indigent household is likely to utilise at least 137 kWh monthly when using the following appliances: one energy saver light, one television set, one iron, one kettle, one hotplate stove and one regular light. Furthermore, Makonese et al. (2006) proposed 200 kWh per month per household to cater for basic household energy needs. Makonese et al. (2006) criticised FBE for being inadequate for household needs, especially as it does not consider large urban households with significant energy demands. The FBE model also promotes a culture of dependency, entitlement and is further argued to inhibit an enterprising spirit among the beneficiaries. Of interest in their argument is resistance by indigent households in accepting the installation of prepaid meters as a means of accessing FBE (Makonese et al., 2006). Reasons range from inconsistent electricity unit prices by Eskom (compared to tariffs set by municipalities; with the latter being higher than the Eskom tariff); to limitations on the number of appliances which can be simultaneously connected to the system in order to avoid tripping. Illegal

electricity connections and by-pass of electricity meters are cited as symptoms of such resistance to prepaid electricity meters. Makonese et al. (2006) cited the Tembisa and Soweto townships as case studies underpinning their research.

1.3.3 Suppressed demand

Winkler and Thorne (2002: 415) noted that "…in poor countries and communities, households demand less services because they cannot afford to buy more. Demand is suppressed or remains suppressed due to a budget constraint or lack of infrastructure". Budget constraints are some of the factors that prevent indigent households from moving to higher levels of consumption even when their needs are inadequately met. The concept of suppressed demand takes into account the fact that indigent households' utilisation of any choice of household electrical appliances and services is suppressed. The status quo could be improved through participation of indigent households in RE as prosumers, which would facilitate access to more (clean) energy at improved affordability levels. As prosumers, indigent households could also produce surplus electricity that could be fed back to the grid, and suppressed demand could thus be addressed.

Improved purchasing power contributes to improved quality of life and higher consumption which could lead to a higher carbon footprint that could 'qualify' for Clean Development Mechanism (CDM) projects with associated credits. Nissing and Von Blottnitz (2009: 2184) supported this notion as they argued that "increased energy consumption is positively correlated to increased quality of life". Middle-income lifestyles are inevitable as an outcome of socio-economic development as people tend to strive for more goods and services once their purchasing power improves.

It is important to mention that cities could also benefit from carbon credits in CDM projects if they demonstrate that their carbon emissions are reduced even as they simultaneously pursue socio-economic development benefits. Suppressed demand also considers that indigent households have close to zero carbon footprint *per capita* and as such have practically no emissions to reduce. By implication, they

cannot benefit from the CDM projects that are specifically framed around claiming of carbon credits based on verifiable emissions reductions.

1.4 Innovative municipal funding and business models

It is critical to explore alternative and innovative municipal business models that would bring the indigent households to the centre of productive energy space whilst exploring ways to increase the currently insufficient 50 kWh to at least 200 kWh as suggested by Makonese et al. (2006). Equitable Share Grant (ESG) municipalities are able to provide Free Basic Electricity (FBE) to indigent households as earlier defined. All their basic services are subsidised by National Treasury through municipalities in the form of ESG. In addition, municipalities have to verify each household's status before it can be registered as an indigent household. ESG is an unconditional grant allocated by National Treasury to all municipalities which they use mainly to subsidise free basic services such as FBE, refuse removal and water. The more registered indigent households, the higher the ESG that municipalities could receive. Since it is a discretionary grant, municipalities are allowed flexibility in the utilisation of the grant within the parameters of facilitating access to basic services for targeted beneficiaries. According to Eskom (2011) (as referenced in Lawrence, 2013), about 1.12 million households nationally took advantage of this programme in 2011. This number could have increased given the population growth and urbanisation in the face of diminishing employment opportunities, thus signifying a growing burden for local municipalities and national government.

The required innovative funding and business models should take into consideration issues such as municipal energy policies, sources of funding, affordability, quality of electricity produced, flexible financing mechanisms, aftersales and operational maintenance costs. Pode (2013) emphasised the need for government to come up with a sustainable, flexible and affordable financing model that can benefit indigent households (with some contribution by end users), in order to ensure long-term economic sustainability. Given the high upfront costs of RE systems, which thus pose a severe bottleneck for the indigent households in accessing RE, government has to address the challenge through development of responsive policies aimed at reducing costs of such systems, promoting tax breaks on RE systems and skills

enhancement to support the development of related income generating activities. Financing mechanisms may include own municipal funds, national government grants, loans, carbon credits, multilateral and/or bilateral funds and equity financing. The fact that municipalities place high reliance on electricity sales for collection of revenue could be an inhibiting factor towards their promotion of RE in their areas of jurisdiction. This dependency on revenue from electricity sales cannot be sustained for long, especially in the wake of implementation of the SSEG initiatives. It can therefore be expected that municipalities' main revenue source will be shaken as major consumers of electricity will most likely choose self-generation through RE. This dependency mode in which both the indigent households and the municipality find themselves in, needs serious and urgent attention. Innovative business models focusing on this challenge could be a key component of the initiative as municipalities could be incentivised to promote RE, and especially solar PV technologies with indigent households in mind which would thus enhance inclusivity.

Local municipalities could play a key role in creating an enabling framework for RE promotion and adoption in cities, though this would only materialise through clear policy shifts and innovative business models. In order to achieve such a shift, Glemarec (2012) argued that development practitioners will need to build a business case for public resource allocation for energy access and such public resources utilised in a catalytic manner to leverage private finance. Glemarec (2012) further asserted that a key challenge for policymakers to leverage private finance lies in identification of policy levers required to remove specific investment barriers such as weak or low levels of affordability, lack of access, lack of appropriate business models, and inadequate cost-effectiveness. It thus becomes imperative for municipalities to have business models that would not only promote RE for indigent households, but also facilitate and leverage private finance for the sub-sector.

1.5 Renewable energy models linked to indigent households

Successful participation of indigent households in the RE energy space is equally dependent on municipalities re-engineering their current regulatory framework. Reviewing the utilisation of the ESG, for instance, could be one way of encouraging indigent households into RE while protecting municipal revenue streams. In addition

to ESG, municipalities could also take advantage of current government funding streams such as rebates, grants and loans. These are accessible from the Department of Trade and Industry (DTI), Eskom, Department of Environmental Affairs (DEA-RSA), Industrial Development Corporation (IDC), and the Development Bank of South Africa (DBSA). Reviewing and regulating the role of the private sector in collaboration with municipalities could also become a very important component of the critical review of enabling regulatory frameworks. It is important to note that many RE projects have low levels of operating costs (Gujba et al., 2012: 75).

With regard to national and international precedents, Paez (2010) and Scheer (2008) presented case studies where pro-indigent households' RE urban models have been implemented. In addition, the University of Stellenbosch has piloted the iShack model aimed at promoting participation of indigent households in RE space through its solar home system (BoP Learning Lab, 2013). Other models include funding models, as well as decentralisation and local production models. An appraisal of such models is presented in Chapter 2 of this study.

1.6 Problem statement

In urban areas, demand for sustainable quality services remains a challenge, particularly for municipalities whose primary responsibility is to provide such services through their own revenue sources such as electricity sales, rates and taxes. Municipalities tend to rely heavily on revenue from electricity sales as their main source of income which is proving to be unsustainable. They are also required to sustainably provide basic services to all their citizens, both indigent households and middle- to high-income households. These basic services include electricity, water, sanitation, refuse removal and housing. Consumers of services are required to pay to access these, and municipalities must perpetually provide despite the rising costs.

Despite government subsidies towards provision of services for indigent households, municipalities grapple with cost escalations on an ongoing basis. These rising costs translate into an increasing cost burden for municipal cost entirely. Equally, the perpetual dependency on municipalities by an increasing number of indigent households continues to be unsustainable. It is therefore critical for municipalities to address this challenge of unsustainable rising costs while they continue to provide

quality services to their citizens in general, and to indigent households in particular. Indigent households fall under the low-income category of the population and cannot afford to pay in full for the cost of services. They thus remain particularly vulnerable to rising costs. On the other hand, in line with national government policy, municipalities are expected to address mitigation interventions to reduce greenhouse gas emissions that contribute to climate change. This requires focused interventions by municipalities, such as reduction of use of electricity from fossil fuels and adoption of Renewable Energy initiatives. Due to the shortage of relevant skills in RE, this shift may take a long time to implement.

The Sol Plaatje Municipality (SPM) was identified as a case study to explore how the above traits and risks present themselves and how they could be mitigated sustainably. Galeshewe township was specifically identified as a case study area as it is home to close to 50% of Sol Plaatje Municipality's population. The township is also characterised by a high number of indigent households. About 6% of households in SPM are categorised as indigent households. Further details about the case study area are contained in Section 1.12.

Arising from this context, the study was guided by two key related objectives as follows:

1. To explore ways in which municipalities could promote renewable energy for benefit of indigent households in order to enhance inclusivity while mitigating energy poverty.
2. To investigate the extent to which such pro-indigent RE promotion approaches could also contribute towards the mitigation of GHG emissions with a view towards low-carbon lifestyles.

1.7 Rationale for the research

I embarked on this research in order to explore these challenges as a basis for conceptualisation of a sustainable solution in the form of an innovative funding and business model, which municipalities could adopt in order to address these challenges sustainably. This research is innovative in that it combines financial aspects and technical aspects of electricity provision, which is seldom done because these aspects are the domain of different sets of experts. A transdisciplinary

approach has been adopted for this research, and the research can be described as collapsing and integrating various knowledge systems into a new way of understanding, which is then applied towards resolving the challenge. It is anticipated that the recommendations of this research would be breaking new ground that would transform the practice of financiers, engineers and municipal officials in the city. It also aims to break down the prevailing silo approach which tends to have limited impact. It is increasingly important for municipalities to carve a new alternative to energy provision for their citizens in general, and for indigent households in particular. Since the study involves a synthesis of various disciplines, its recommendations could be used by these various disciplines as mentioned above.

1.8 Research questions

This research aims to explore how different funding streams and business models can be combined in an innovative way that ensures benefits for municipalities and indigent households. It explores how the transition to RE could be made while mitigating the problem of "exclusionary greening" of South African cities, with a focus on the case of the Sol Plaatje Municipality. The research attempts to answer the following questions:

Question 1: What are the key characteristics of the current funding and business model for electricity provision to indigent households for Sol Plaatje Municipality?

Question 2: What would be the innovative funding and business models which could allow both indigent households and the municipality to benefit from the transition to renewable energy technologies and services and thus mitigate their prevailing vulnerabilities?

1.9 Working hypothesis

An appropriate combination of funding and business model, combined with the right technologies, can allow indigent households to participate effectively in RE whilst benefiting from, as well as contributing to, energy and revenue generation.

1.10 Definition of key terms

This section provides an overview on the definitions of the key terms used in the study:

Free Basic Electricity – Free Basic Electricity (FBE) is premised on government policy aimed at improving access to electricity for indigent households. It is subsidised through the Equitable Share Grant which National Treasury allocates to all municipalities annually. It takes the form of pre-determined monthly allocation of 50kWh electricity per registered indigent household and is supplied by an electricity distributor, which is either a municipality or ESKOM.

Indigent Households – Indigent households are classified as households whose total monthly income does not exceed R3 500 per month. These households fall within the low-income group of the population. Municipalities provide subsidised basic services to these households. This includes electricity, water, refuse removal and housing. It is important to mention that not all indigent households live in government subsidised formal housing. Some reside in either backyards at formal housing settlements or in informal settlements. The study is focused on indigent households who reside in formal government subsidised houses.

Energy Poverty – Energy poverty refers to inadequate access to sufficient energy by the indigent households, mainly due to the fact that they cannot afford to purchase adequate energy, thus resulting in them being trapped in a cycle of budgetary constraints and suppressed demand. This perpetual cycle of insufficient energy for household consumption has a negative impact on indigent households' general quality of life.

Energy Burden – Energy burden is defined as the proportionately high cost that indigent households face in accessing energy for household consumption. The monthly percentage of energy expenditure in relation to monthly income of around R3 500.00 is relatively high and falls between 12% and 20%. Indigent households are generally faced with large financial burdens compared with middle income households. Such a high energy burden is a contributory factor to the indigent households' compromised quality of life.

Supressed Demand – Winkler and Thorne (2002: 415) argued that "Demand is suppressed or remains suppressed due to a budget constraint or lack of infrastructure". Budget constraints are some of the factors that prevent indigent households from moving to higher levels of energy consumption. Suppressed demand also refers to a state of unmet potential demand for additional household appliances that indigent households could purchase to improve their quality of life in addition to the basic ones they currently utilise. The concept of suppressed demand takes into account the fact that indigent households' utilisation of household electrical appliances is suppressed. Energy poverty, high energy burden and lack of affordability contribute to suppressed demand as households are unable to purchase and utilise additional appliances or the required energy supply for their basic needs.

Business Model – This refers to an adopted conceptual approach and method of doing things by an entity. In this study, a business model refers to a new way of providing solar electricity to indigent households as a means to mitigating the risk of exclusion based on their socio-economic status. Through a business model, a municipality must adopt a particular approach to addressing the problem of energy poverty underpinned by financial and regulatory considerations.

Prosumer – Prosumers are defined as consumers and producers of electricity simultaneously. Surplus electricity that they produce in their households is fed back to the grid at a fixed tariff they can claim from the municipality. Prosumers benefit financially from feeding surplus electricity to the grid and can claim back thus benefitting financially. A clear policy coupled with a responsive infrastructure that caters for prosumers has to be developed by a municipality.

1.11 Delimitation of scope

Given the focus of the study on innovative business and funding models that municipalities could adopt to enable indigent households to participate in RE, it is important to mention that there are various related fields and issues that this research could not address. These include municipal governance issues, leadership, socio-political-economic issues, as well as procurement frameworks or processes. This research is an attempt to bring 'new proposals'. The focus is on indigent households and electricity provision specifically and not on the whole municipality's

governance. It is also beyond the scope of the study to address whether or how the proposed model will be implemented. In addition, issues that relate to broader systemic implications of implementing RE do not form part of this research as they are secondary to a business and funding model, instead they form part of the RE implementation value chain. As a result, details on ways of facilitating participation of prosumers on RE through feeding power back to the grid, in what form and whether into municipal or ESKOM national grid, are excluded from this study. Instead, the study assumes that such policy and related engineering concerns can be addressed once the business model has been conceptually proven or viable. The proposed business and funding model therefore serves as the primary focus as it deals with basic issue of the 'what', while detailed implementation is secondary (the 'how') and is considered beyond the scope of the research. Further research could be done on systemic implementation of the proposed model to determine its impact. This study is also confined to indigent households who own and live in government subsidised houses and does not factor in those who live in other forms of accommodation such as informal settlements and backyard dwellings, especially where tenure is uncertain.

1.12 Overview of Galeshewe settlement

The study prioritised Galeshewe as the case study area because it had the common attributes of townships primarily settled by indigent households and was also very familiar and easily accessible to the researcher. The township is located within the Sol Plaatje Municipality in the Northern Cape Province of South Africa. Section 4.2 further elaborates on the case study area dealing with analysis of secondary data on the demographics of the township. With high numbers of indigent households residing in government subsidised formal housing which also enjoy government subsidised solar water heaters (SWHs), the case study can assist in answering the research questions. The fact that some indigent households have access to SWH (a form of RE technology) may provide more insight into indigent households' immediate experience of RE and possible concerns for innovation and improvement. For the target households, any future implementation of RE would be an extension of what they are currently familiar with.

The location of the case study area is Galeshewe, which is a predominantly black township established under the Group Areas Act, Act 41 of 1950, within the Sol Plaatje Municipality (SPM) in the Northern Cape Province (see Figure 1.1, 1.2, 1.3 and 1.4).

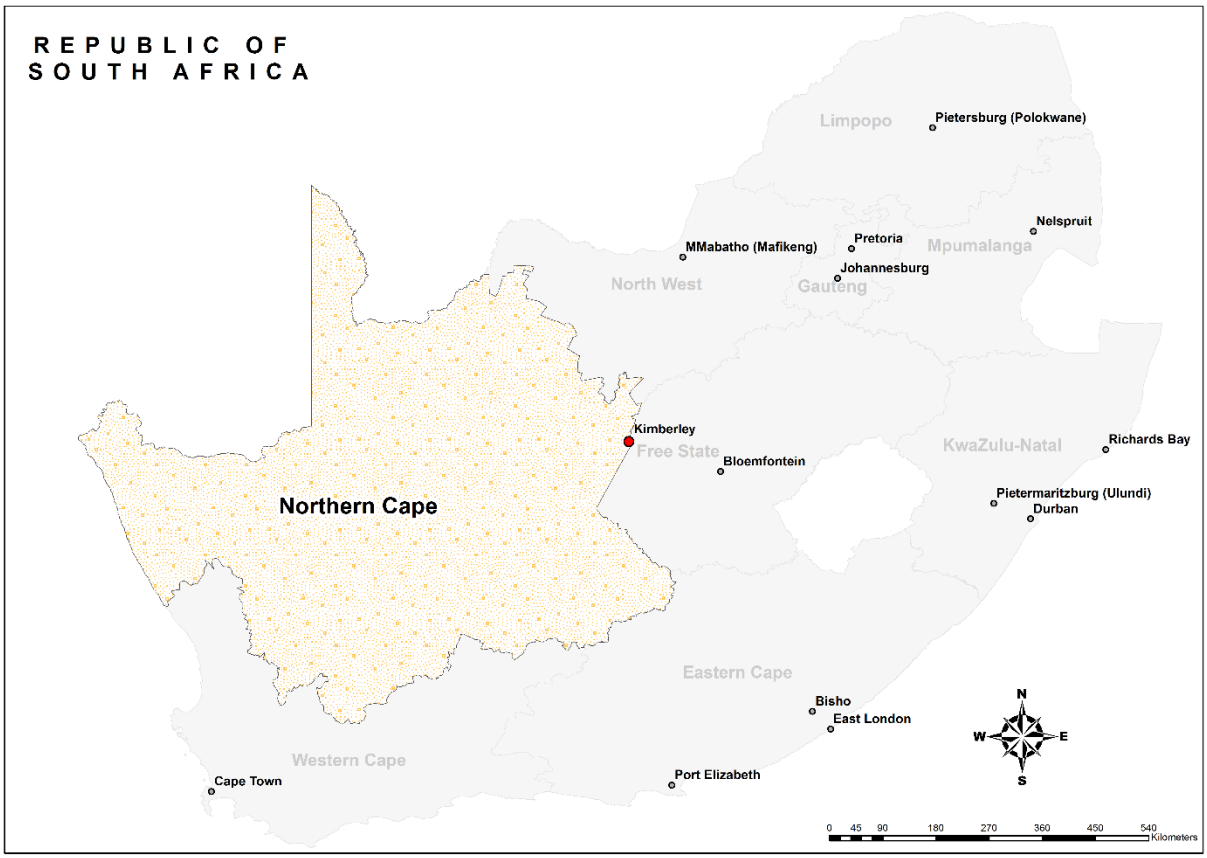

Figure **1**.1: Map of South Africa showing the Northern Cape Province (Source: SPM, 2016)

According to the 2011 Census (StatsSA, 2011), SPM has a population of approximately 250 000 people. Its main economic drivers are in the tertiary services sector which includes trade, retail, community services/government and tourism, and it thus enjoys minimal industrial, agricultural or mining activities. Sol Plaatje is the name of the greater municipality, while Kimberley is the name of the capital city which is located within the SPM. Kimberley serves as the seat of government for the Northern Cape Province and it hosts the provincial legislature, high court, the newly opened Sol Plaatje University (since 2013), as well as the headquarter offices of all provincial/national government departments in the province.

Sol Plaatje Municipality is the largest of the four local municipalities within the Frances Baard District Municipality and has highest GDP in the district (Figure 1.2).

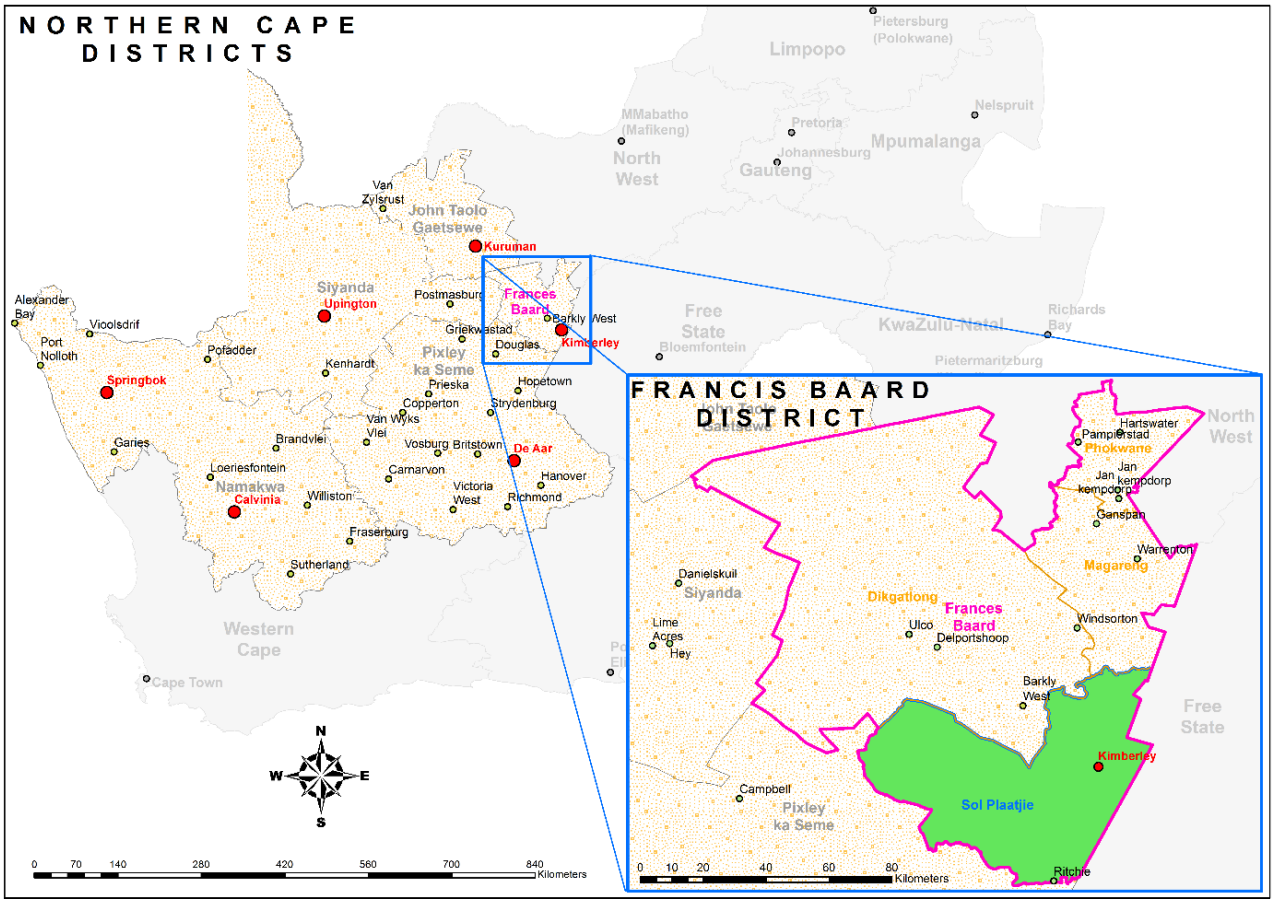

Figure 1.2: Map of Sol Plaatje Municipality within the Frances Baard District Municipality (Source: SPM, 2016)

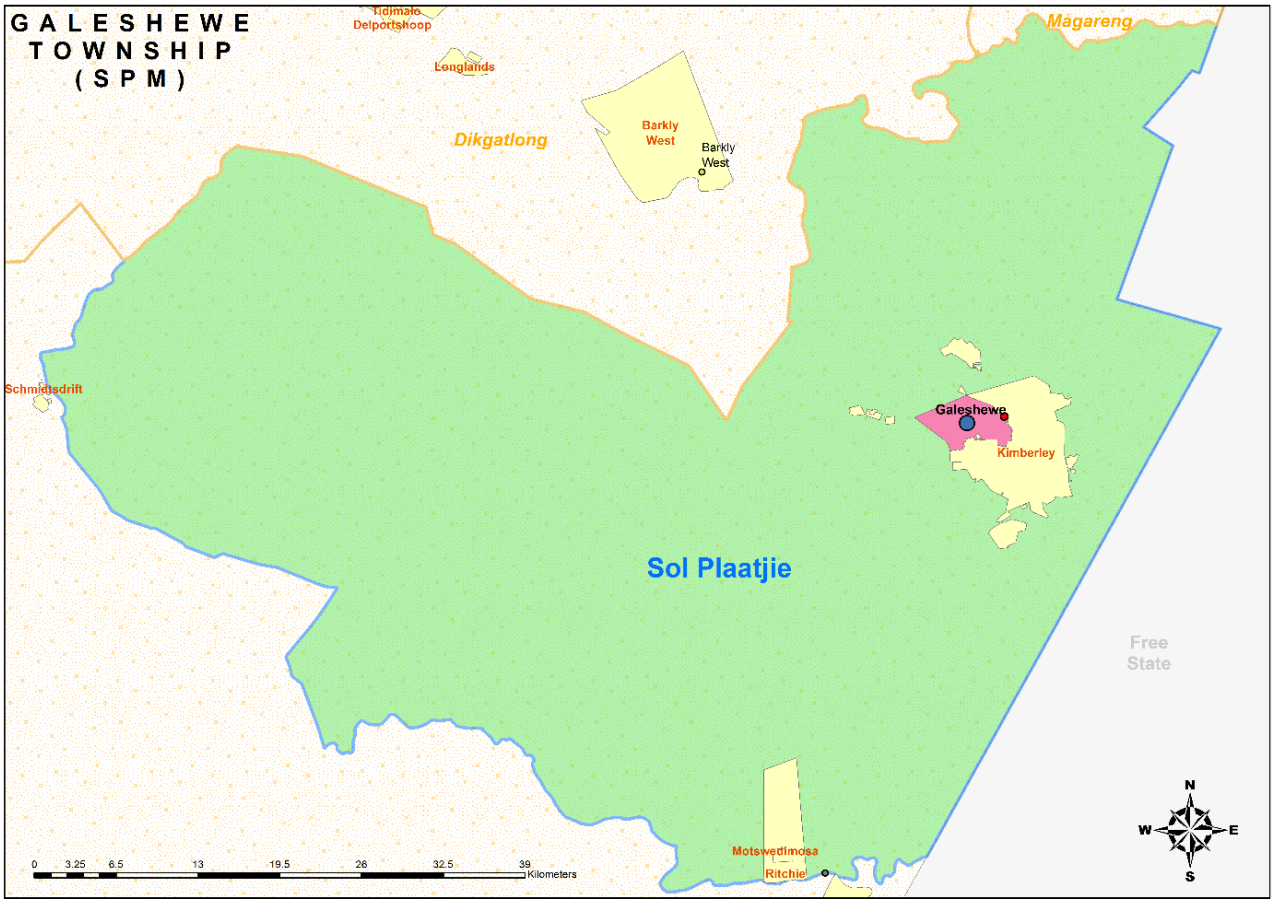

Figure 1.3: Map showing Galeshewe in the Sol Plaatje Municipality (Source: SPM, 2016)

Galeshewe Township hosts close to 43% of the SPM total population, which translates to about 108 000 people and approximately 25 400 households. This reflects an average household size of 4.2 as compared to a national norm of 3.3 (StatsSA, 2015). In spite of its formation under apartheid laws, and also unlike other South African townships that are located in the periphery of major economic nodes/towns, Galeshewe is located approximately 3 km from Kimberley CBD. For example, distances between other townships and respective CBDs range between 17 km (the case of Gugulethu-Cape Town) to 27 km (Soweto-Johannesburg). Galeshewe's close location to the CBD offers unique advantages for its inhabitants. People walk, cycle and drive from Galeshewe to the CBD of Kimberley and are therefore easily able to seek employment, recreational and social services in close proximity to the city's amenities. However, like all South African townships, its population is faced with challenges of inadequate formal housing which results in informal settlements on municipal land pockets, as well as high unemployment levels. Economic and educational opportunities within the SPM attract more people

from the province and from outside the province, resulting in high demands for housing, energy, water, as well as other services. Recently available data indicate that Galeshewe has the highest standard of municipal services provided and a good quality of life in general compared to other South African townships, and this also applies to the entire municipal area of SPM. According to StatsSA (2011), provision of municipal services within SPM is at an average of 78%, with electricity provision being the highest at 84.9%. There is good access to educational and health facilities and all are within close proximity to all residents. SPM provides a high level of electricity service (60 Amp) to its indigent households, which is 20 Amp higher than the national norm. Even though it provides 60 Amp, indigent households are only allowed the national limit of 50 KWh monthly, which is low and insufficient for the electricity requirements of most households.

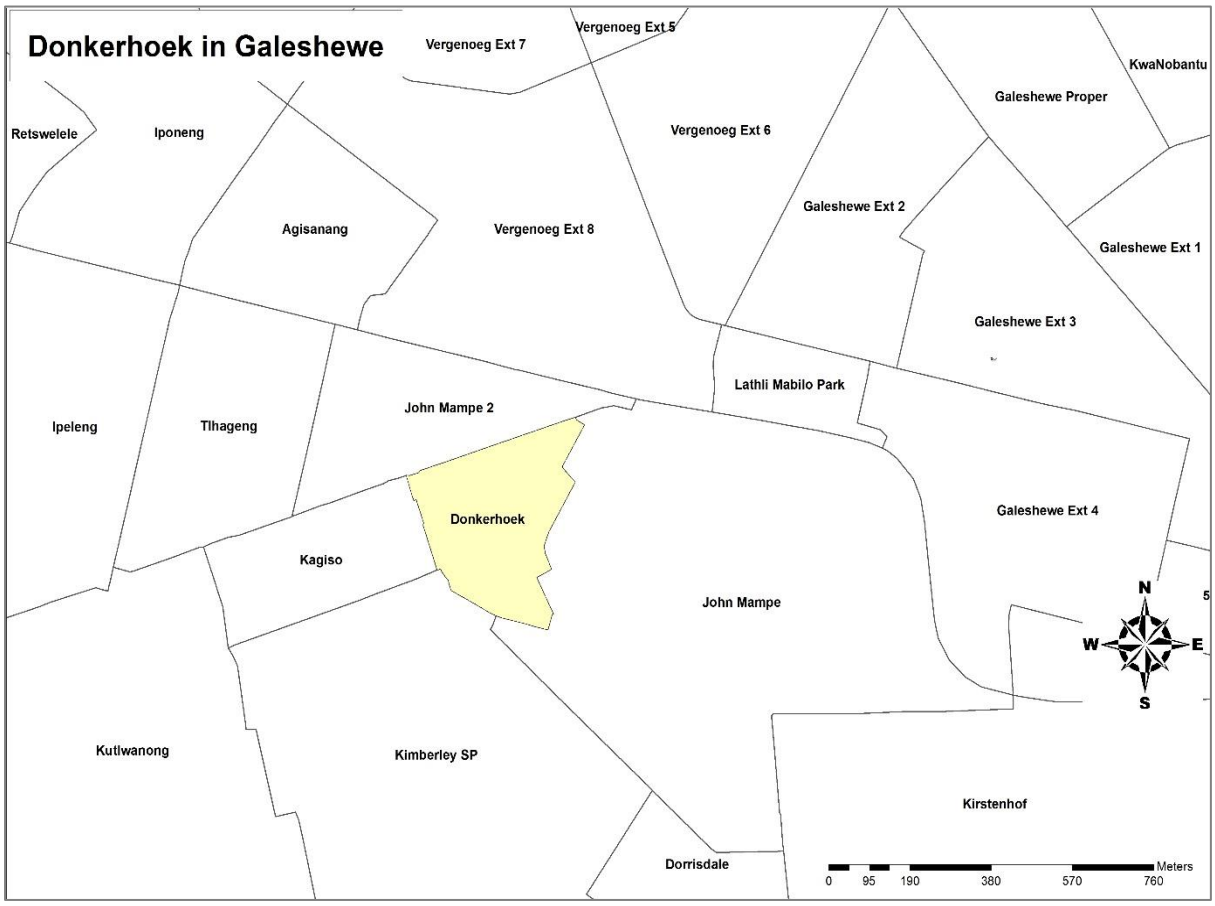

Figure 1.4: Map showing Donkerhoek in the Galeshewe area (Source: SPM, 2016)

1.13 Structure of research report

This research report comprises six chapters. The first chapter gives a general introduction. Chapter 2 explores literature linked to the research, while Chapter 3 deals with methodology and ethical considerations. It is important to highlight the approach used in presenting this research report as its analysis is spread over Chapter 4 and Chapter 5. This is because each research question is addressed separately through detailed analysis of primary and secondary data. This has resulted in the research report comprising six chapters. Chapters 4 and 5 are analysis chapters which explore the key characteristics of the current funding and business model for Sol Plaatje Municipality (SPM), and the innovative funding and business model, respectively. The final chapter, Chapter 6, outlines recommendations and proposals.

Chapter 2

Literature appraisal: Improving access to energy by indigent households

2.1 Introduction

This literature review explores in more detail the role of energy provision in social, environmental and economic development and the challenges and opportunities for improving access by indigent households to electricity from renewable energy (RE) sources. The emphasis is on literature that is relevant to the Southern African RE context. The first two sections provide a theoretical background on energy poverty, energy access and development and related quality-of-life in general. The subsequent sections bring together literature on existing government and private sector initiatives around access to energy, precedents on pro-indigent urban RE models, appropriate RE technologies, decentralisation and local production models as well as funding models.

Literature on business and funding models for RE promotion for indigent households emphasises the key participants and contributors, primarily in public and private sectors as well as the end-user. Each participant plays a distinct role in ensuring that the indigent households effectively participate in RE, particularly in solar energy technologies. Any funding and business model proposed and implemented would be futile if any of the key participants fail to participate effectively. Some of the scholars on funding and business models whose studies have been appraised in this chapter are Ameli and Kammen (2012), Bhattacharyya (2013), Glemarec (2012), Gujba et al. (2012), Keller (2012), Lawrence (2013), Patlitzianas and Christos (2011) and Pode (2013).

2.2 Exploring the impact of energy poverty

One of the key characteristics of energy poverty is limited access to modern, clean energy sources particularly by low-income households. Globally, 2.5 billion people meet their primary energy needs through consumption of biomass (TERI, 2008) and 1.6 billion people still do not have access to electricity (United Nations Development Programme [UNDP], 2000). TERI (2008) also estimated that close to 2.5 million deaths per year can be attributed to indoor air pollution-related diseases. This situation is caused by the emission of toxic particulate and smoke matter, due to inefficient combustion of fuels as sources for domestic energy services. Scholars refer to the concept of 'energy poverty' when describing the interrelationship between poverty and access to energy. Silva and Nakata (2009: 3097), for example, described energy poverty as "the condition where people cannot afford access to a sustainable energy supply". For Khandker et al. (2011: 894), energy poverty is "the point at which people use the bare minimum energy (derived from all sources) needed to sustain life". The UNDP (2000: 44) defines energy poverty as "the absence of sufficient choice in accessing adequate, affordable, reliable, quality, safe and environmentally benign energy sources to support economic and human development". Energy poverty is as a result of socio-economic poverty which leads to limited access to sustainable energy supply. This results in inefficient energy consumption patterns by the indigent households in the form of burning of traditional fuels in inefficient appliances. Pollution and related negative health impacts are some of the outcomes linked to energy poverty. Key components in the energy consumption space include access, affordability and benefit derived from an energy source. Enhanced affordability is able to mitigate energy poverty and suppressed demand.

Keller (2012) has described an 'Energy Poverty Nexus' in order to substantiate how poverty influences fuel choices of indigent households, and conversely, how their fuel choices can have poverty entrenching dynamics. "Without access to, and the transition to affordable forms of clean appropriate energy, many of the world's indigent households are 'locked into' livelihoods, which are often unnecessarily environmentally damaging, unhealthy and uneconomic" (Howells et al., 2010: 2730). In essence, at the core of this argument is the nexus between energy and poverty, in

that limited access to clean energy services entrenches poverty in all its related dimensions. In support of Keller's argument, Pachauri et al. (2004) substantiated the relationship between energy and poverty as one of mutual causation. The provision of clean and reliable energy sources can be a catalyst for human development, as recognised by many international agencies and development practitioners (Keller, 2012: 51). The OECD (2012:1 5) asserted that "the predicted increased water shortages and increased energy and water costs will impact particularly hard on poor households".

The reality is that indigent households are often precluded from enjoying modern energy services due to insurmountably high access costs (Elias and Victor, 2005; Masera et al., 2000; TERI, 2008) or due to their sensitivity to price changes, resulting in uncertainty in their ability to afford the service (Price, 2000; Sovacool, 2011). Given that their choice in livelihood and access to basic services is marginal, focused government intervention is of utmost importance. As RE technology costs are declining, it can no longer be argued that the indigent households cannot access RE for improved livelihoods on the basis of relatively higher costs. This notion is supported by Koot (2014), chief executive officer of Solarplaza, a leading global solar energy conference organiser, whose view is that solar production costs have declined as much as 60% since their 2008 highs and may continue to decline into the foreseeable future. This can be regarded as an indication of continually improving levels of affordability and thus enhanced opportunity for transitioning to RE for all, but more specifically for indigent households.

According to Nissing and Von Blottnitz (2009: 2184) "increased energy consumption is positively correlated to increased quality of life". Households who can afford this would enjoy improved access to a broader range of choices of energy sources in contrast to indigent households whose affordability levels are marginal and very often uncertain. It is thus of significance to consider the broader range of benefits which an energy source offers, rather than "merely the source of energy itself" (Nissing and Von Blottnitz, 2009: 2184). Affordability, access and related benefits derived from a source of energy are key components in energy consumption space so as to realise socio-economic and environmental benefits associated with RE.

It is critical to create enablers for indigent households to transition into accessing energy for both consumptive and productive services, thus contributing to their improved well-being and long-term economic development. Nissing and Von Blottnitz (2009) distinguished between primary energy service needs and secondary energy service needs, namely energy for consumptive purposes only and energy for productive purposes as well, which have a positive contribution to long-term economic development. Their argument correlates with Kicinski's concept of 'prosumers', namely consumers of energy who are simultaneously producers of energy (Kicinski, 2013).

Based on the above appraisal, it is evident that indigent households are negatively affected by energy poverty which results in not only limited access to sustainable clean energy sources, but also to the poor health as well. Poor health conditions in turn are a burden to both the affected households as well as the government which has to provide health services at a cost. This ultimately constitutes a negative impact on taxpayers who eventually carry the cost of provision of health services. The challenge of energy poverty need not be isolated to affecting indigent households in accessing sustainable clean energy, but has to be understood within a context of a cost to both the affected households and government, including municipal authorities. For indigent households, the cost has implications for socio-economic, environmental and health conditions, while for government it is directly linked to environmental and budgetary costs. Some municipalities provide health services to their citizens, whose related budgetary costs are covered by the municipalities' revenue combined with subsidy from the provincial department of health.

With the arguments made so far, it is clear that access to adequate energy by indigent households as consumers is still a challenge mainly due to lack of affordability. If they can afford to access more energy, indigent households would derive more benefits from enhanced energy services.

2.3 Energy access-benefit nexus

Access to reliable and clean energy is not only a prerequisite for improved quality of life of indigent households as a segment of the population but is also one of the key variables for economic growth and well-being of all citizens. Small and medium

enterprises are especially sensitive to reliable energy services and are a vital source of employment for indigent households (Clancy et al., 2008; Saghir, 2004). Access to reliable and clean energy constitutes a basic human right (Makonese et al., 2006). Kimemia and Annegarn (2012: 103) argued that government should therefore prioritise energy provision alongside water, food, health, and education. The arguments of Makonese et al. (2006) as well as Kimemia and Annegarn (2012) concur on the issue of access to energy services by indigent households. They argued that lack of access to energy services slows down economic growth, thus resulting in increased dependency and a welfare society. A holistic approach is therefore needed. When embarking on any energy/electrification programme for indigent households, be it based on conventional or renewable sources or technologies, it is important that consideration is given to the broader range of social, environmental and economic development impacts.

Kimemia and Annegarn (2012) argued that energy plays a positive role in poverty alleviation, and further noted that affordability improves households' economic well-being, which thus refers back to the concept of reversing suppressed demand. The indigent households have an ability to reverse suppressed demand should their economic circumstances improve. In general, a rise in income leads to increased energy consumption up to a point from where it then levels off. These trends may be difficult to observe at the micro level, especially for the indigent households, which may be reliant on non-monetary income streams or are reliant on the self-sourcing of fuels (Elias and Victor, 2005). From a macro-economic perspective, however, the relationship between energy consumption and income is clearly discernible. According to Saghir (2004: 3), "no modern economy has managed to drastically reduce poverty without concomitant increases in energy consumption". Nissing and Von Blottnitz (2009) argued for the positive role played by access to appropriate energy in poverty alleviation and sustainable development, as well as meeting the Millennium Development Goals (MDG) on energy. However, as asserted by TERI (2008), increasing access to energy itself is not an automatic stimulant of economic development. Rather it is a necessary, but yet insufficient input for socio-economic development.

Whereas the indigent households cannot shift to RE voluntarily, the government can facilitate such a shift in various ways as substantiated in Chapter 6. Ondraczek (2013) conceded that affordability and availability are major drivers that enable widespread adoption of off-grid solar technologies, while on the other hand, Glemarec (2012) noted the critical paradox where prices of energy from fossil fuel technologies continue to increase, while prices of RE technologies are rapidly falling. This implies that transitioning to RE does not only make environmental sense but is also increasingly making economic sense. In line with Glemarec's (2012) argument with regard to falling RE technology prices, Scheer (2008) argued that solar radiation resources are more widely available and hence overall costs (initial plus operational costs) can be expected to continue to decline compared to those of electricity generated from fossil fuels such as coal. This technological and cost-reduction gain in RE should thus be harnessed towards addressing the energy needs of indigent households in a more comprehensive manner.

2.4 Government Initiatives towards access to energy

Various studies have so far criticised FBE provision as insufficient while also highlighting the need to revise the related policy. Keller (2012), Makonese et al. (2006) and Ruiters (2009) among others, argued that 50 kWh allocation is insufficient, especially for the most energy intensive activities such as cooking and water/space heating, which therefore result in continued use of unsafe fuels by beneficiary households. Keller (2012) highlighted the shortcomings of FBE with regard to the 50 kWh of monthly electricity being provided and also emphasised the continued unacceptability of installation of prepaid meters in order to access the FBE subsidy. Simulating energy demand of an indigent household's most essential energy services (excluding entertainment, communication and cleaning) demonstrates that FBE allocation only caters for between 14% and 19% of a typical low-income household's energy needs, depending on the season (Adam, 2010: 43). In line with Keller (2012), Makonese et al. (2006) criticised FBE as being inadequate for realising improved quality of life for the indigent households. FBE is further criticised for not considering large urban households with multiple energy demands (Makonese et al., 2006) and is also viewed as promoting a culture of dependency, entitlement and a lack of enterprising spirit by citizens. It further makes no provision

for energy services for indigent households not connected to the grid, thus failing to reach those in greatest need (Keller, 2012; Makonese et al., 2006). This substantiates the exclusionary impact of FBE even in cities as the indigent households continue being marginalised with regard to their basic energy needs.

Various scholars as appraised here have criticised FBE of 50kWh as insufficient to cater for individual indigent household's basic needs, only providing up to 19% of their energy needs. Although this argument is consistent amongst the studies reviewed above, it is critical to consider other factors as they relate to increased FBE. Such considerations include the cost of increased FBE to taxpayers who ultimately pay for the grants. Should government consider an FBE increase, an investigation should be done to explore the best funding mechanism for additional FBE. An increase in FBE would have a significant impact on tax payable to government. In spite of an anticipated cost escalation in the wake of an increased FBE allocation, government needs to balance its interventions on improving access for indigent households to energy with the cost it bears to provide quality basic services to all its citizens including such indigent households. The government would also need to balance the cost linked to increased access to energy for indigent households with the cost of interventions towards mitigation of greenhouse gas emissions and climate change. Current government interventions towards addressing climate change are acknowledged. Public-private partnerships could also be critical towards increased FBE allocation, as government and/or municipalities alone will not carry such a cost on their own. Inherent in increased FBE subsidisation is affordability by government. Another aspect to consider regarding increased FBE subsidisation is its impact on suppressed demand of indigent households. Increased FBE could trigger indigent households' entrepreneurial potential, thus addressing their socio-economic status. Criticism of insufficiency of 50kWh as depicted in various literature above therefore needs to be seen in the light of and balanced with affordability by government as well as impact on suppressed demand by indigent households.

Davidson (2006) asserted that the government stated its objective of 100% access to electricity by 2010, although it was not clear if the intention was 100% grid electricity or if some of this could be off-grid. The quantity of electricity for each household has

yet to be decided. Originally, the plan was to supply households with 350 kWh/month, but experience has shown that newly connected households were only able to consume between and 75 kWh and 250 kWh per month, with an average of about 100 kWh/month (Prasad and Ranninger, 2003). Provision should still be made for higher consumption, because it is known that better access to affordable electricity leads to the development of other productive activities that would translate to more use of electricity. Further policies would be required to ensure the realisation of such a reality. In line with Ruiters' (2009) and Makonese's (2006) argument on the insufficiency of 50 kWh, both Davidson (2006) and Prasad and Ranninger (2003) have motivated for increased energy access. Considering that the Prasad and Ranninger (2003) article predates this study by fourteen years, it is assumed that consumption has increased such that the maximum of 250kWh per month could be considered as the minimum threshold for indigent households.

Moreover, Adam (2010) and Ruiters (2009) argued that the practice of reducing consumption through current limitation (by insisting on the installation of 10–20 Amp supplies) increases the incidence of electrical tripping. At this level, a maximum load of 4.5 kW can be placed on the line making the concurrent usage of numerous appliances such as a kettle, cooking and lighting impossible. "The poor are forced to accept sub-standard services (like the 10 Amp supply, which trips when several appliances are used simultaneously), in exchange for a small amount of FBE. Rather than uplifting them, the onerous means of access and the punitive, self-targeted pre-restriction (the 10 Amp service) represent a cynical attempt to manage this sector of society, rather than provide genuine and adequate relief from poverty and social exclusion" (Ruiters, 2008: 249). In addition, installation of prepaid meters is enforced as a requirement for accessing FBE (Adam, 2010) and has some unavoidably severe consequences for indigent households. It "…force[s] poor households to consume less by cutting themselves off. So, rather than the city having to go in and cut off … for non-payment, the city lets the technology do it for them. They simply distance themselves from the 'structural violence' of cost recovery" (Ruiters, 2008: 258). Also, the erratic and irregular income stream of indigent households does not allow them to purchase large amounts of electricity credits in advance (Energy Sector Management Assistance Program [ESMAP], 2007). In the likely event of FBE allocation running out during the month, electricity credits are

purchased frequently and in small amounts, resulting in repeated trips to electricity vendors. Consumers often have to commute to vendors thus incurring additional transportation costs as well as an increased exposure to the risk of muggings (ESMAP, 2007). If repeat purchases are not imminently possible, indigent households may lose additional money if food in their fridges starts to rot (Ruiters, 2008).

The current limiting and controlled access to energy through installation of specifically designed electricity infrastructure, prepaid meters, as well as limited electricity capacity of up to 20Amp all contribute to the risk of exclusion of indigent households in energy system and associated benefits. Such technologies and interventions further add to energy poverty. Irregular income streams further entrench indigent households into energy poverty.

Ruiters (2009: 249) summed up the main arguments against FBE and placed them within a political context noting that “FBE, at one level, is about the state caring for the people’s welfare; at another level, it may be understood as a way to isolate and manage the ‘problem’ of mass poverty in South Africa. One key aim of the state is to fight a perceived ‘culture of non-payment’ for services and promote more acceptable market behaviours amongst its citizens”. Administrative techniques and engineering technologies (such as prepayment smart cards) have thus been developed for demarcating some users as indigent households and facilitating controlled access. Thus, ‘indigent household’ is concluded to be synonymous with limited access, sub-standard service, poverty and socio-economic exclusion.

Despite the shortcomings and criticisms associated with FBE, there are numerous benefits associated with it, which the Energy Sector Management Assistance Programme (ESMAP) (2007) listed as follows: (1) manual meter readings are no longer required; (2) billing becomes redundant; (3) no more overdue accounts or bad debts; (4) makes budgeting of energy consumption easier; (5) no customer complaints regarding bills; (6) no more dependence on potentially inefficient postal service; (7) transparent and equally applied automatic disconnections; and (8) job creation at vending stations. What emerges is that most of these benefits accrue to municipalities, private electricity vendors and the electricity utility, ESKOM, in areas

where the latter supplies electricity directly to household consumers. The positive trait linked to indigent households relates to (7) above.

2.5 Precedents on related renewable energy models

Through various reports and case studies, it is evident that there have been various efforts to promote access and participation of the indigent households in RE through solar home systems. Such precedents, from both South Africa and internationally, are appraised in the subsequent sub-sections.

2.5.1 iShack concept: A sustainable energy solution for informal settlements

In South Africa, the Sustainability Institute, in partnership with Stellenbosch University and Stellenbosch Municipality, conceptualised and prototyped a PV solar home system, under the brand name 'iShack' ('improved shack'), in Enkanini informal settlement in Stellenbosch. This urban RE model aimed at facilitating indigent households in the informal settlement with access to clean and affordable energy. Funding was received from multiple sources including national and international funders such as DEA's Green Fund, as well as the Bill and Melinda Gates Foundation in the United States. According to the BoP Learning Lab (2013), the iShack concept embraces the notion of incrementalism, which forms part of a bigger concept of informal settlement 'incremental upgrading', thus improving the quality of people's lives incrementally. This model is the first of its kind in South Africa. Its objectives are similar to the objectives of this study as they focus on how to provide clean and affordable energy to the indigent households in urban areas, even though it is located within an informal settlement as opposed to formal township housing which constitutes the focus of this study.

The iShack model is underpinned by a business model that has the end user as a key contributor as it recognises that people living in informal settlements are able and willing to pay a contribution for basic services such as energy, and therefore seeks to leverage the existing infrastructure and entrepreneurship already present in typical informal settlements (BoP Learning Lab, 2013). As Pode (2013) argued, although it is government's responsibility to provide basic services to all its citizens, including the indigent households, it is critical to ensure that such services are not

provided free of charge, but should instead facilitate the user to pay based on a responsive model. This argument has been put in practice through the iShack initiative as users are charged fee-for-service. Transitioning to mobile solar home systems as well as 'pay for service' is supported by Glemarec (2012: 88) whose argument is premised on country-context development where there is anecdotal evidence that telecom services can unlock entrepreneurship and promote economic development, as well as promote access to energy (RE). Mobile telecom technologies can be an effective way to facilitate access to energy by indigent households even for solar energy: "the poor have the capacity and the willingness to fully or partially pay for services that provide clear, immediate and substantial benefits" (Glemarec, 2012: 88). The key issues of importance in Glemarec's (2012) study are a mobile and affordable system, public private partnership (PPP), and the concerns that sometimes people pay for luxuries at the expense of their basic needs, and an affirmation that the indigent households would willingly pay for energy services.

An iShack is a specially designed shack or an informal house that is aimed at ensuring affordability, access, ecological sustainability, as well as enhancing thermal comfort through passive thermal control measures. An experimental shack was fitted with RE technology, a DC (direct current) multigrid system inclusive of two indoor lights, a cell phone charger and an outdoor motion activated security light (Keller, 2012). DC multigrid system lights replace paraffin and candles. Costs of the experimental shack were linked to the entire experiment, namely including all preparatory work and construction of additional shacks for comparison purposes. The overall study thus entailed a control shack, a retrofitted shack and the iShack. In 2012, the maximum cost of an iShack was R5 811.00 for 14.26 square metres, inclusive of a DC multigrid system. However, it is likely that overall costs have since escalated, even though the real cost of the energy technology could have decreased in line with global trends.

Figure 2.1: Direct current multigrid system (Source: Keller, 2012)

Keller (2012) concluded that the iShack study indicated improved thermal comfort performance when compared to a retrofitted shack or a typical shack. What is profound in the iShack model is that at the conceptual stage of the project, vigorous communication took place between the Sustainability Institute and Stellenbosch University. The community, through local community leaders, assured their willingness to pay and high levels of commitment by end-users themselves were evident. End-users contributed financially to the development of the model, with some users contributing through sweat equity.

Figure **2**.2: Indoors of an original/control shack (Source: Keller, 2012)

Figure **2**.3: Indoors of an iShack (Source: Keller, 2012)

Keller (2012: 118) further highlighted the key advantages linked to the iShack innovation as follows: “Additional energy-shelter interventions through the iShack concept have potential to achieve the following socio-economic benefits: improved economic standing of households through guaranteed mobile connectivity; improved health of occupants through reduced traditional fuel usage for space heating; have positive impact on education of child learners through an opportunity to study after hours; improved social networks through a greater interaction with friends and churchgoers. Occupants would feel safer at night given the outdoor security light; and it would encourage households to invest further in their dwellings.”

The iShack roll-out to the entire Enkanini informal settlement was funded through the Green Fund by the DBSA at a cost of R17 million. This business model enables the provision of electricity to informal settlements at low monthly instalments which would otherwise not have been feasible. The iShack model is thus a proven South African model targeting the urban residents in informal settlements. Lessons learnt from the iShack model have been applied to this study as substantiated in Chapter 5, as both studies target the low-income segment of urban population where weak affordability of energy services remains stubbornly prevalent.

What stands out in the implementation of the iShack model is its comprehensiveness as underpinned by engagement with key stakeholders in the private sector, end-users, community leaders as well as adaptation of government contributions to realise both the community and government’s objectives. For the end-users, the

iShack model demonstrated improved quality of life, reduced energy poverty and improved access to energy, whilst for government the benefit was in line with the reduction of greenhouse gas emissions. Leadership and public participation were central in implementing this model. This is an indication that a successful energy model that is aimed at benefitting indigent households has to incorporate similar building blocks and process. These include government, private sector, end-users, leadership, affordable and mobile technology as well as ongoing contributions by the end-user in order to access the energy service.

2.5.2 Solar water heaters

In an attempt to address carbon emissions through participation in RE, the South African government has embarked on a massive roll-out of solar water heaters (SWH) to subsidised housing targeted for indigent households. These SWH initiatives could have been planned to include the integration of solar PV and solar home systems as suggested by Ameli and Kammen (2012), Glemarec (2012) and Pode (2013). It was decided to discuss SWH in this chapter because it would be of value to use it as a basis on which to build other related RE models and technologies. Equally, as argued through previous studies as appraised above, any RE technology needs to be integrated into hybrid systems in order to ensure optimum benefits for end-users. Given that there is already access to RE services through SWH by indigent households in Galeshewe in the Sol Plaatje Municipality, further participation in RE can be regarded as familiar and could minimise risk of acceptance of the shift to RE.

2.6 Appropriate renewable energy technologies

RE technologies form part of the RE value chain. Promotion of access to RE goes beyond just having a business model with financing mechanisms but should also incorporate the broader spectrum of the RE continuum in order to deepen its socio-economic benefits. For example, the use of combined systems for both heating and cooking could accelerate the adoption of RE solar stoves, and in areas where people prefer squatting when cooking rather than standing, a system designed for such preferences could be prioritised (Glemarec, 2012). Energy storage is one of the important aspects to consider in solar RE production, harvesting and conversion and

it could be in the form of battery systems as suggested by Glemarec (2012) and Scheer (2008). Zhao et al. (2012) put emphasis on environmental benefits associated with RE. RE residential products play a role in energy conservation and carbon emissions reduction. For example, since the Northern Cape (the case study location) is very hot and dry, especially in summer, it could adopt a multipurpose appliance model that combines air-conditioning with cooking (for cooling and heating respectively) which would allow the cooler/heater to be active while cooking, and a cell phone charger may be combined with the television or other appliances. In that way indigent households could be encouraged to buy into the concept of transitioning to RE much faster, which would in turn call for voluntary purchasing of appliances, possibly with government participating as a partner on behalf of the indigent households. Such a multipurpose hybrid approach to technology and appliances could form part of an awareness and marketing strategy for low-carbon transitions.

From a climatic context/perspective, since Kimberley is very hot in the summer and cold in the winter, multipurpose technology could be considered. One example could be technology meant for cooking that also performs as an air conditioner, cell phone charger combined with a television or any other appliance. Mobile and affordable technologies are also emerging as an ideal way to promote RE in low-income areas. The municipality could further consider accessing solar energy through the internet as part of the 'Internet of Things' and the possibility of promoting responsive partnerships with private sector. This could be similar to the current purchasing of electricity using mobile phones through commercial banks based on online platforms. Glemarec (2012) advocated for mobile energy devices and made a comparison with the emergence of cell phones and how they have impacted the low-income in emerging markets. The reading further argued that in developing countries there is anecdotal evidence that telecom services can unlock entrepreneurship capacity and drive, as well as promote economic development, and access to energy, with particular reference to RE. The principle of a 'user pays' would be applicable here, wherein indigent households also contribute towards technology and home systems. The repayment process would have to be determined.

2.7 Decentralisation and local production models

Scheer (2008) argued for a decentralisation and local production model for solar energy, where production and consumption are localised and integrated. It offers the potential to capacitate households as energy producers who thus produce and supply whilst consuming from the local grid ('prosumers'; Kicinski, 2013: 749). Bischof-Niemz (2015: 3) from the CSIR stated that "government and the CSIR are working to develop a model that will provide rooftop solar PV owners a guaranteed 20-year tariff for supplying electricity to the grid and compensate municipalities and Eskom for losses of revenue from electricity sales". Thus, CSIR is busy with a proposal to promote prosumers, which would entail turning consumers into producers of electricity. In addition, Nissing and Von Blottnitz (2009) argued in support of adequate energy being accessible for both consumptive and productive purposes, thus offering a positive contribution to long-term economic development. Decentralisation and a regional distribution model turns cities into solar power stations, where solar power facilities are spread over a wide area and also close to points of consumption, thus promoting the local economy (Scheer, 2008). The key advantages associated with the decentralisation and local production model are that energy is fast to import, and investments can be made on the basis of demand, thus mitigating bad investments especially on surplus generation capacity for long-lead time projects (Scheer, 2008).

Linked to the decentralisation and localisation model is the Feed-In-Tariff (FiT) model, where consumers are paid for energy exported to the grid as determined through a net-metering system and underpinned by a responsive FiT policy. Conventional meters are replaced with smart meters that are equipped to differentiate between energy consumed by consumers and surplus energy fed to the grid. Should municipalities adopt such a policy, it would mean that indigent households would not only benefit in terms of access to energy for daily consumption but also financially as they could sell extra energy to the grid. This would constitute a mutually beneficial approach towards transitioning from fossil fuels to RE (Gujba et al., 2012: 75). Under the FiT model, RE is recognised as both a consumptive and productive energy service, as opposed to the conventional model where production and consumption are separated or incompatible processes.

Scheer (2008) further argued that solar radiation is widely available and hence overall costs of solar energy generation are regarded to be low. The study asserts that “the first step is to realize that it is finally time to make full use of the most important infrastructure in the city: the Sun” (Scheer, 2008: 26). In RE generation and conversion, storage such as in the form of battery systems is becoming a crucial component. In order to be efficient with regard to storage facilities, what becomes important is to consider decentralisation of solar power facilities through regional and local networks (micro-grids) instead of over-dependence on the national power grid (Scheer, 2008). Solar power facilities would thus be spread over a wide area, which would in turn promote local production and economy.

As argued by Scheer (2008), decentralised solutions would be more attractive provided that responsive technological innovations are pursued and sustained. Costs associated with transporting primary fuels are immediately cut out of the value-chain when utilising solar PVs, as solar radiation is automatically available on site at no cost (Scheer, 2008: 22). The study further predicted electricity distribution through networks and micro-grids to support both consumption and general localised entities.

The decentralisation and local production model is premised on improved efficiency, cost effectiveness, risk mitigation as well as promotion of entrepreneurship, in line with Prasad and Ranninger (2003; see Section 2.5). Construction of power stations would be based on demand, as opposed to the current model of centralised electricity generation. Also, energy transportation costs would be reduced thus mitigating the financial risk. Another form of risk mitigation is through localised routine maintenance as when there are technical faults, only the affected area is inconvenienced and not the wider location. A further benefit of this model is effective and improved planning and general operations as the stations are smaller. It would therefore be to the advantage of municipalities to consider a decentralisation and localised model based on these positive attributes. For example, India embarked on a Decentralised Distribution Generation (DDG) to electrify mainly its rural areas. Benefit associated with DDG was reduced Transmission and Distribution losses (Arunachalan et al., 2016).

Scheer (2008) emphasised that economies which entirely depend on the centralised grid will either have to pay the ever-rising costs of electricity or the state will have to

subsidise costs. This argument resonates with the objectives of this study in that indigent households are the ones primarily at risk of being rendered dependent on the grid despite government's effort to promote RE, because the latter benefits those who can afford the transition The argument of local energy production by local consumers is gaining strong attention from scholars. Scheer (2008: 26) further acknowledged that "solar energy is becoming a value-added factor to the city and its inhabitants, and the city becomes more prosperous and a better place to live with clean air which is good for health". The model of local production is regarded as a good business case and its implementation is increasingly becoming feasible and critical.

2.8 Energy performance business model

In addition to the models highlighted above, there exists a business model termed Energy Performance Contracts (EPCs), which could be one of the innovative implementation tools used by municipalities shifting to RE. According to the SACN (2016), EPCs are types of contracts used to deliver energy savings, whereby the cost of investment into energy efficiency projects is paid back through accumulated savings over time. In this model, risks are either on private sector implementers or shared by both private sector and the municipality concerned. The cost of investment into energy efficiency projects is paid back through accumulated savings over time.

There are two types of EPCs: the Guaranteed Savings model and Shared Savings model. The main difference between the two is that in the Guaranteed Savings model, the municipality provides upfront investment, while the private sector or service provider financially guarantees that projected energy savings will be achieved. With the Shared Savings model, the municipality does not have to raise funds to finance the energy project as that is the responsibility of the investor. Cost savings are then split between the municipality and investor (service provider). The Shared Savings model has been identified as a preferred model for municipalities. An additional way to fully utilise the EPC Shared Savings model is to apply it to energy efficiency initiatives for municipal buildings which could result in an improved financial base for the municipality as it will no longer spend as much on electricity consumption for its own buildings.

2.9 Towards a funding model

The aforementioned components of business models would not be sufficient on their own without a sustainable funding model. For an investment in RE to be sustainable, it must have a positive Net Present Value (NPV) (Patlitzianas and Christos, 2011). In addition, it is important to apply a systems approach which is underpinned by interdependence of parts within a system or a 'whole'. "The innovations that will have the most significant impact will be ones that integrate complete value chains around securing long term viability for social and ecological as well as economic systems" (Senge, 2006: 352).

Access to, and continued affordability of clean energy sources could be facilitated through carefully designed financial interventions that have wide ranging poverty-alleviating effects (Keller, 2012: 2). For effective participation of the indigent households in RE, government, the private sector, as well as users, need to work collaboratively. This is achievable through a bottom-up approach, whereby the end-user has some form of contribution such that a sense of ownership and control is upheld.

2.9.1 Funding options

Sources of funding for RE access can be categorised into international public finance, bilateral and multilateral funds, domestic budgets and carbon finance (Glemarec, 2012). Misuka Green Development Solutions (2012: 8) argued that in order for South Africa to achieve the goal of reducing carbon emissions, it is prudent for government to develop a national green financial architecture that would attract private and international development finance through some domestic public investment, thereby creating investor certainty. Bhattacharyya (2013: 467) suggested that municipalities "could also develop incentives for investors on RE …" The Green Fund, through the DEA-RSA (2016), is regarded as a step in the right direction towards promoting the country's transition to low carbon emissions. Its role is that of a catalyst in the transition towards a green economy and it seeks to unlock barriers and bridge the gaps wherever they exist along the innovation value chain. It provides loans, grants and equity to the private and public sectors. This is one of the

mechanisms that could be considered by municipalities to co-fund RE for the indigent households. The DoE-RSA could be approached to fund capacity building.

As a state-owned entity under the auspices of the DoE-RSA, the Central Energy Fund (CEF) could be considered given its mandate that includes the promotion of RE (CEF, 2014/15). Through its Integrated Annual Report, CEF reports a budget of R1 billion to embark on RE initiatives which have a good ROI (CEF, 2014/15: 77). The Report further mentions that the Ekurhuleni and Nelson Mandela Bay municipalities partnered with CEF through installation of SWH. Since there is not much RE footprint shown by the CEF in municipalities to date, it can be regarded as a platform on which to partner with municipalities in pursuit of the realisation of its RE mandate.

In addition, the 'Adoption of the Paris Agreement' – COP 21 – by the United Nations Framework Convention on Climate Change (UNFCCC, 2015:16), "resolves to enhance the provision of urgent and adequate finance, technology and capacity-building support by developed country Parties in order to enhance the level of ambition of pre-2020 action …" and in this regard, strongly urges developed country Parties to scale up their level of financial support, with a concrete roadmap to achieve the goal of jointly providing USD 100 billion annually by 2020 for mitigation and adaptation while significantly increasing adaptation finance from current levels and to further provide appropriate technology and capacity building support". This is a relatively recent Agreement, concluded in December 2015, and its resolutions could address the promotion of RE for the indigent households especially in developing country cities.

Pode (2013) highlighted that Africa forms part of several multilateral funds which include the CIF and Adaptation Fund. International multilateral funds, such as the Climate Investment Fund (CIF) through the World Bank and the European Union could be accessed for RE promotion. Bhattacharyya (2013: 471) concluded that very little attention has been given to multilateral financing of RE projects in developing countries and emphasised the need to redress this disparity. Multilateral financing tends to focus on large projects implemented in large economies. This presents an opportunity for further exploration for RE promotion for indigent households. National government has to play a leading role in this instance.

Philanthropic Investment is another source of funding that could be considered. Philanthropist Bill Gates, who invested over $1 billion in RE, is now looking to double that amount as he views investing in technology companies as the best way to find cost-effective solutions to climate change (Matthews, 2015). The Bill and Melinda Gates Foundation invested in iShack as elaborated in Section 2.5. On the other hand, Warren Buffet invested $30 billion in RE, and more than a billion dollars in solar energy alone, including the massive Agua Caliente solar array in Arizona (Matthews, 2015).

One of the financing options for informal settlers, as noted in Keller (2012), is personal revenue streams, funds borrowed from friends/family, as well as savings and credit cooperatives (also commonly known in South Africa as Stokvels). Although Keller (2012) focused on a case study in informal settlements, a similar approach could also be explored for indigent households in formal housing.

2.9.2 Carbon trading and the clean development mechanism

Another financing option that could be considered is carbon financing through carbon trading based on reduced carbon emissions and can be traded globally as Voluntary Emissions Reductions (carbon neutral) (Keller, 2012: 131). The Clean Development Mechanism (CDM) allows an emitter in a developed country to invest in an emissions-reduction project in a developing country (Gujba et al., 2012). The use of carbon financing through CDM (under the Kyoto Protocol) was successful for the Kuyasa project in the Khayelitsha township of the Western Cape where 2 309 Reconstruction and Development Programme (RDP) houses were retrofitted with energy efficiency and RE interventions, thus achieving a 2.85 tons reduction of GHG emissions per low-income house per year, in addition to day-to-day energy savings already realised by occupants (Goldman, 2010). Linked to the Kyoto Protocol, is the Adaptation Fund and the Green Investment Fund and Energy+ (Gujba et al., 2012; Bhattacharyya, 2013).

According to Gujba et al. (2012), Africa has seen 2.6% of CDM projects thus far, a percentage that could be increased through initiatives such as the innovative municipal funding and business model proposed in this study. Disappointingly, Africa in general was bypassed by carbon markets due to high level transaction costs of

projects, and low levels of verifiable reductions in GHG emissions due to prior levels of underdevelopment. However, two African projects benefitted from carbon trading: eThekwini Municipality's solid waste project in South Africa and West Nile Rural Electrification Project in Uganda (UN Habitat, 2015).

As noted in Gujba et al. (2012: 74), the UNFCCC (2015) observed that there has been a growing interest from Programmes of Activities (PoA) where Africa has 22% of registered projects, and such projects demonstrate lower transaction costs. Gujba et al. (2012: 74) further noted that "the introduction of a standard which addresses the suppressed demand for services may make the PoA even more appealing in the context of energy access in Africa". In addition to CDMs and PoAs, the Nationally Appropriate Mitigation Action (NAMA) programme constitutes another financing mechanism, but it is still in its early stages. Through a mixture of public and private finance, the NAMA is likely to translate into more carbon credits realised and can be directed to financing low carbon infrastructure in developing countries. Thus, a total of 6 581 tons of GHG emissions are annually avoided as a result of the Kuyasa intervention.

One of the key lessons learnt from the Kuyasa CDM project is the feasibility of the 'pay for service model' as part of additional upfront finance for initial and incremental capital costs by beneficiaries (Misuka, 2012: 18). This is similar to the argument put forward by Glemarec (2012) and Keller (2012) whose notion is premised on the 'user pays' approach.

The Green Climate Fund (GCF) that was endorsed at COP 17 in Durban in 2011 is another form of carbon finance to be considered. Glemarec (2012: 91) asserted that governments may benefit from GCF when they embark on a large number of small-scale energy access projects within a single umbrella initiative. The prosumer approach as substantiated in this study can be considered as one such project which could benefit from the GCF.

2.9.3 End-use level financing through MFIs

Bhattacharyya (2013: 471) and Pode (2013) emphasised the role played by microfinance institutions (MFIs) in financing RE solar systems. End-use level

financing is a combination of diverse funding mechanisms as elaborated in the subsequent sub-sections. On a small-scale, multilaterals provide microfinance for onward lending to final users. As an example, the Sarvodaya Economic Enterprise Development Services Guarantee Ltd. (SEEDS), a microfinance institution (MFI) in Sri Lanka, uses this model in a World Bank supported project where it provides 25%–30% of energy access costs (Bhattacharyya, 2013: 471). The MFI model supports the 'user pays' concept (Glemarec, 2012; Misuka, 2012; Keller, 2012).

The DoE, as South Africa's designated national authority under CDM, could also be approached to fund capacity building. According to the DoE (2013), South Africa already has CER buyers and investors which include the Central Energy Fund, DBSA, IDC, Nedbank, and Standard Bank.

2.10 Conclusion

Based on the insights from the literature appraisal, it becomes evident that indigent households are systematically excluded from access to clean energy. Key themes that emerge are access, affordability and benefit. Effective funding and business models that focus on improved access by the indigent households to RE, as well as affordability of a chosen technology, are important elements in promotion of participation by indigent households in the RE space. Government's role in seed-funding as well as responsive policy and regulatory frameworks (acting as catalyst for other funding streams) have been equally emphasised. In addition, it emerges that funding from national government (various departments) and climate funding for RE promotion is available, however focused effort is needed by municipalities to access it. Domestic funds and international funding sources can be accessed for RE promotion for indigent households. Africa and South Africa are member states of some multilateral funds, and that is an opportunity for government to champion.

With the plethora of available funding options that could be used to promote RE for indigent households, as well as various relevant business models, it is possible that shifting to RE might cost the Sol Plaatje Municipality a minimal direct funding injection.

Chapter 3

Research methodology

3.1 Introduction

The study is based on a mixed method approach with a qualitative case study as the key method. Although it is primarily qualitative, it has quantitative elements as demonstrated within the sections and chapters of the study. Qualitative research methods differ from quantitative methods, employ different philosophical assumptions, strategies of enquiry and methods of data collection, analysis, and interpretation (Creswell, 2009: 173). Qualitative research provides an opportunity for the researcher to develop empirically supported new ideas and theories through systematic enquiry into meaning (Ospina, 2004: 1). Qualitative research methodology assists in describing reality within the real world of experience, in context and in real time. In other words, the researcher attains “a glimpse of the world” (Creswell, 2009). A qualitative approach emphasises qualities of entities, processes and meanings that are not experimentally examined or measured in terms of quantity, amount, intensity or frequency (Centre for Teaching, Research and Learning, 2015).

The researcher has a distinctive role to play while conducting qualitative research: “all qualitative researchers aspire to illuminate social meaning” (Ospina, 2004: 4). They try to understand meaning from the respondents’ perspective rather than explaining it from the outside. With a qualitative approach, research questions often stress how social experience is created and is given meaning (Centre for Teaching, Research and Learning, 2015).

Another characteristic of qualitative research is the combination of multiple sources of data such as interviews, observations and documents. The researcher must review and make sense of data then organise insights into themes that cut across all of the data sources in order to derive findings. Qualitative research is emergent and dynamic thus an initial plan for research may change or shift after the researcher enters the field and begins to collect data (Centre for Teaching, Research and

Learning, 2015). Qualitative research also constitutes a form of interpretive inquiry in which researchers make ongoing interpretations of what they see, hear, experience and understand (Creswell, 2009: 176).

Researchers in a qualitative study often apply an inductive data analysis approach with the aim of uncovering patterns, categories and themes from the bottom up into a more abstract level of information, insight and understanding. This inductive process includes working back and forth between themes and the data base until a researcher has established a comprehensive set of themes which correlate with the study objectives and address the research questions. Creswell (2009: 175) further defined characteristics of qualitative research, highlighting how the researcher focuses on learning about the meaning that participants hold about the phenomenon, and not the meaning that the researcher brings to the research. The focus is on participants' real experiences and researchers put themselves in other people's shoes (Sutton & Austin, 2015). Creswell (2009) further asserted that a qualitative researcher aims to identify and report multiple perspectives on a phenomenon.

These characteristics were applied at various stages of the study, especially during one-on-one interviews, as well as in Section 3.4 where raw data were analysed and categorised into themes in response to the key objectives and sub-questions of the study. In gathering primary data, the researcher engaged with respondents through face-to-face interviews.

3.2 Data used to answer the research questions

Table 3.1 below summarises the data sources and methods of collection in order to address each of the research questions. Presentation of information in tabular form is effective in providing direct links between research questions and the data collection sources. Analysis of research question 1 is elaborated in Chapter 4 through data analysis of primary and secondary data, while detailed analysis of primary and secondary data for research question 2 is presented in Chapter 5.

TABLE 3.1: DATA SOURCES AND COLLECTION TOOLS

Research Question	Type of Data	Application / Analysis
Question 1: What are the characteristics of current funding and business model for electricity provision to indigent households for Sol Plaatje Municipality?	Primary data in the form of interviews: These were obtained through semi-structured interviews with municipal personnel from finance and electricity departments In the case of indigent households, primary data were also obtained through semi-structured interviews with households in Donkerhoek who have SWH already installed in their homes. Secondary data: Secondary data were in the form of municipal finance policies and the budget book for municipal annual budget allocations; policies from national departments (DoE and DEA) and StatsSA (2011 Census data) so as to understand the demographics of the case study area and to ascertain income streams and future plans with regard to RE.	To determine how the municipality spends on its FBE. Determination of budget projections for electricity Risks associated with exceeding the 50 kWh currently provided, for example electricity theft, mitigation of such risks to ascertain RE strategies/ policies and planned programmes as the municipality voluntarily participates in alternative energy initiatives To ascertain the budget spent on electricity, preferences and purchasing behaviour. Secondary data To determine any relevant alternative funding streams to implement a funding model
Question 2: What innovative funding and business models could allow both indigent households and the municipality to benefit from the transition to renewable energy technologies and services?	Primary data in the form of semi-structured interviews: Primary data were obtained through semi-structured interviews with municipal personnel from the department of finance and department of electricity on how current grant funding could be used to promote RE, namely grant from the National Treasury – ESG and grant from the DoE- the Integrated National Electrification Programme (INEP). Data on urbanisation and migration patterns were obtained through a semi-structured interview with urban planning. Secondary data:	Primary data To determine the future demand for basic services such as electricity. To determine urbanisation and migration patterns and respective causes.

	Data were obtained from municipal finance policies and the budget book for budget allocations. Policies from national departments (DoE and DEA) so as to ascertain funding streams and future plans with regards to RE, such as Green Fund. Other data were gathered from the private sector platforms such as PPPs, philanthropic investments, etc., climate finance such as international funding options for RE, multilaterals, bilaterals, and carbon finance. Information on the iShack solar home system was obtained from secondary sources. Other secondary data sourced from the Internet were as follows: (i) Green Climate Funding; (ii) iShack information with the DC Multigrid mobile system; (iii) the DBSA Green Fund; (iv) International Council for Local Environment Initiatives (ICLEI) Additional information was obtained from DoE documents on Nersa's Small-Scale Embedded Generators' – Draft regulations for public comments	<u>Secondary data</u> In addition to determination of future budget policy prescripts and allocations, data were analysed on the entire value chain of iShack solar home system

Research question 1: "*What are the key characteristics of the current funding and business model for electricity provision to indigent households for the Sol Plaatje Municipality?"*

In addressing this question, primary data in the form of semi-structured interviews with municipal personnel from the Departments of Finance and Electricity were collected and analysed. The selection of Finance Department personnel for primary data collection was due to their primary role in financial regulation inclusive of management of all municipal grants, including the Equitable Share Grant and disbursement of Free Basic Electricity to registered indigent households. They also manage the registration of indigent households in the municipality. Similar tools of semi-structured interviews were used to collect data from the five purposefully sampled indigent households located in Donkerhoek. The selection was based on

affordability and beneficiary qualifying for the FBE programme. The selection of respondent households is elaborated in Section 3.3.

Secondary data sources included municipal finance policies, policies from DoE-RSA and the DEA-RSA. Data sources from the municipal Finance Department were also identified in order to gain more insight into municipal policies and budget allocation for bulk electricity from Eskom, for FBE, as well as for other relevant provisions. Secondary data sourced from national policies were meant to facilitate understanding of the current and future plans with regards to RE. The municipal Electricity Department was identified as a source of data on the municipal electricity sector as well as managing and operating provision of electricity infrastructure to indigent households. The department is also responsible for administration of the Integrated National Electrification Programme (INEP). Secondary data were further sourced from StatsSA (Census data) due to the need for understanding socio-economic demographics of the case study area and to gain insight on current and future affordability levels. Primary data and secondary data mentioned above are analysed in Chapter 4 which addresses the first research question.

Research question 2: "*What would be the innovative funding and business models which could allow both indigent households and the municipality to benefit from the transition to renewable energy technologies and services and thus mitigate on their prevailing vulnerabilities?"*

In line with data collection sources mentioned in Table 3.1, primary data were sourced through semi-structured interviews with respondents from Town Planning, Finance and Electricity Departments. Primary data sourced from Town Planning on migration patterns and urbanisation trends of the municipality were linked to demand for basic services and spatial configuration of affected areas. Primary data from the Finance and Electricity Departments were sourced so as to provide insight on how current ESG and INEP funding sources could be used to promote RE.

Secondary data were obtained from DoE and DEA policies so as to identify potential RE funding streams and RE future plans such as the draft Small-Scale Embedded Generators Regulations as published for public comments (NERSA, 2015). Additional data were sourced from the municipal Finance Department on related financing budgetary allocations. Other secondary data were sourced from online

sources on private sector and international funding options for RE such as climate finance, private sector on philanthropic investments, multilaterals, bilaterals and carbon credits. Data on iShack solar home systems were obtained through secondary data sources as well. Other secondary data on funding sources for promotion of RE including the Green Climate Funding, International Council for Local Environment Initiatives (ICLEI), RE technologies, users' contributions, capacity building and training among others were sourced from the Internet. Primary data and secondary data are analysed in detail in Chapter 5 in addressing research question number 2.

3.3 Interview data

Two key types of respondents were interviewed for primary data collection. These were energy policy-makers and implementers, as well as energy end-users. Policy makers are government entities, mainly national government, with municipalities being the main policy implementers and users being consumers, especially indigent households.

Face-to-face interviews allowed the researcher some level of control over the line of questioning in order to keep the focus on the question and responses in relation to the data needed. Participants could also give additional substantiation to add value to the data collected.

3.3.1 Indigent household interviews

Five households were purposefully sampled within the formalised area in the Galeshewe-Donkerhoek township (see Figures 3.1 and 3.2 below). The purposeful sampling was guided by the criteria of being resident in a government subsidised house with a government subsidised solar water heater. In addition, criteria of at least one house per street was applied in Donkerhoek. The main reason for prioritisation of the Donkerhoek section of the township was its longevity associated with its proclamation and establishment (the late1990s) (StatsSA, 2011).

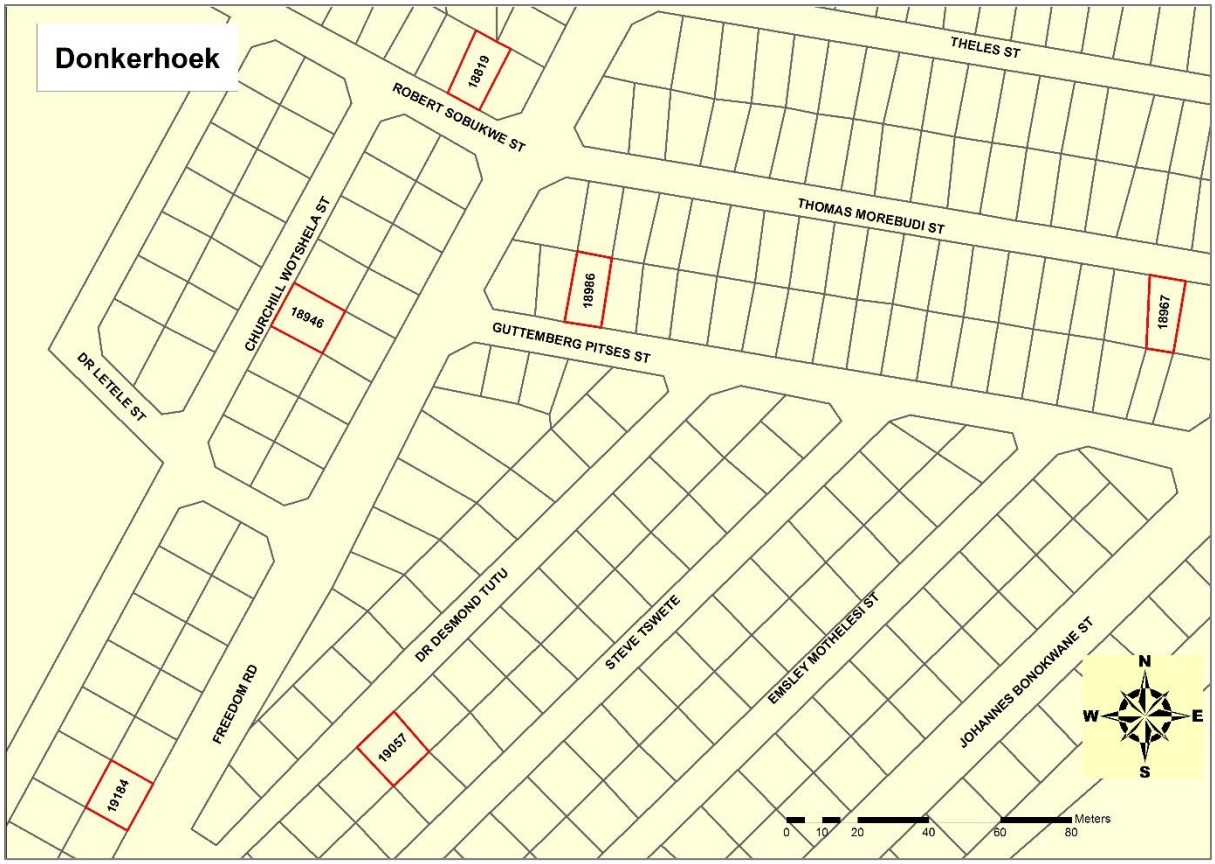

Figure 3.1: Map showing the identified households in Donkerhoek (Source: SPM, 2016)

Figure 3.2: Indigent house (Source: Researcher, 2016)

With regard to preparations for the interviews with respondents from indigent households, prior contact was made with the selected households and the purpose of the interview was explained. Similar to the approach for the municipal respondents, the researcher communicated the purpose of the interview and the study, the fact that it was not obligatory to participate and/or answer any questions they might feel uncomfortable with, that their participation was voluntary and that no rewards were to be expected from the participation. All the respondents from the identified households agreed to participate. One interviewee preferred to sign for consent only after having answered the questions, citing a concern over signing documents while not sure of what they entailed which could be risky for her and her family. After the interview, the respondent was comfortable to sign the forms. All interviews were conducted in the afternoon during the week so as to ensure that those who were working were back from work. In all the households, the researcher was received with warmth and the respondents were willing to participate. Detailed findings of household interviews are captured and analysed in Chapter 4. Further detail on interview questions are contained in Appendix B.

3.3.2 Municipal interviews

The respondents were informed that it was not obligatory to participate. In order to allay any concerns or misperceptions, the researcher explained that the exercise was for academic purposes. The researcher also communicated beforehand with all respondents in order to confirm the process and to help build trust. All respondents, including the municipal manager, showed their support and cooperation both when the researcher sought permission to conduct interviews as well as during the interviews. The respondents were also willing to go an ‘extra mile’ in sourcing additional information where necessary.

As initially anticipated in the research approach, a snowballing effect emerged with some respondents referring me to other personnel in the same unit who dealt with particular matters regarding specific follow-up questions. In most cases, one finding would lead to other factors that needed further research through semi-structured interviews and/or through secondary data from reports and policy documents. This was particularly the case with the finance and infrastructure directorates. Initially, the researcher had planned to interview at least one manager from each directorate.

However, due to specialisations within the directorates, the researcher was referred to additional personnel who dealt with specific aspects relating to interview questions. In the analysis stage of the study, the researcher kept in contact with the respondents on issues that required further clarity and level of detail, long after the formal interviews had been conducted; the respondents enthusiastically provided positive feedback. This was a highly fulfilling experience in the study process. Further analysis linked with municipal interviews can be found in Chapters 4 and 5.

3.4 Data analysis

Data from primary and secondary sources were analysed and categorised into themes, patterns and tables based on the parameters arising from the research sub-questions. References were made to the case study database where actual evidence is found in the form of text, spreadsheets, photographs, field notes and audio files as the additional tools and techniques.

Primary data were summarised and analysed in a spreadsheet, with emerging themes coded under similar categories as reflected in Tables 3.2 and 3.3 below for municipal and household data analysis respectively. Detailed analysis and findings are reported in Chapter 4.

TABLE 3.2: MUNICIPAL DATA CODING

Category	Code
Movement trends	AA
Risks (various)	BB
High quality electricity provided	CC
Subsidisation and funding availability	DD
Limited electricity access to indigent households	EE
No prosumers	FF
No shift to RE by municipality despite decrease in electricity revenue	GG
Insufficient budget allocation for FBE	HH
PPP initiatives	JJ
Institutional readiness for RE	KK
Revenue	LL
Lack of affordability	MM

TABLE 3.3: HOUSEHOLD DATA CODING

Category	Code
Female	A
No matric	B
51 to above 60 years	C
Income R2 000	D
Unemployed	E
Pay for electricity	F
Electricity R0–R100 pm	G
Electricity R100–R300 pm	H
Electricity R300–R500 pm	I
Use of candles	J
Use of paraffin	K
Use of kerosene gas	L
Suppressed demand	M
Electricity bill be reduced	N
SWH improved quality of life	O
SWH decrease electricity bill	P
Solar as alternative	Q
R430 average energy cost per household	R

3.5 Ethical considerations

Given that the interviews were conducted within the researcher's workplace, it was critical that the process was transparent, with the necessary consent and authorisation received from both the supervisor who is the municipal manager, as well as individual consent from the managers interviewed. The municipal manager authorised that the researcher took time off to interview personnel who were contacted prior to the interviews to explain the research topic and objectives of the study. Copies of the ethics clearance certificate and questionnaires are attached as Appendices A, B and C to this research report. All respondent's names were organised by the use of pseudonames in the report (see pages 66, 72).

Chapter 4

Current funding and business model for electricity provision to indigent households in the Galeshewe township – Donkerhoek

4.1 Introduction

This chapter analyses data related to the first research question on the key characteristics of the current funding and business model for electricity provision to indigent households in the Sol Plaatje Municipality. As mentioned in Chapter 3, in answering this question, the study analysed primary data gathered from municipal personnel and respondents from indigent households, as well as secondary data sourced from StatsSA (2011 Census data) on demographics of the study area. Secondary data analysed from StatsSA were considered critical for understanding the socio-economic situation of the study area and would thus influence the recommended model for RE transitioning by indigent households. It is important to note that secondary data on demographics were reworked data which were adapted from StatsSA with several implications as discussed in Section 4.2.3. This also highlights the risks that could face both the Sol Plaatje Municipality and indigent households in the future. Inclusion of secondary data in the form of demographics is also regarded as demonstration of correlation between the status quo and how it affects affordability and sustainability. This enables a more systemic understanding of the problem, as recommended by Senge (2006). This chapter also elaborates on grant funding and related implications, access to electricity by indigent households and RE technology experiences at household as well as at municipal level. The findings and conclusions from data analysis thus form the basis for the proposed funding and business model.

4.2 Secondary data analysis on demographics

It is important to note that although geographic contextual description and purposive sampling of the case study area are elaborated in Sections 1.1 to 1.3 and Section 3.3 respectively, this section analyses demographics as part of secondary data. It is

of critical significance to emphasise that this data analysis is not part of the of case study description. Data were analysed to explore characteristics of the study area which were not immediately available from published sources.

According to StatsSA (2011), SPM is the largest local municipality in the Frances Baard District Municipality whose area is 3 142 km², with Kimberley as its largest urban node.

Based on the data set in Table 4.1, SPM has a high youth unemployment rate (41,7%) with a high dependency ratio of 51. The World Bank (2017) defines the age-dependency ratio as the ratio of dependents (people younger than 15 years or older than 64 years) to the working age population. It is also often used as an indicator of the economic burden that the productive portion of a population must carry. The Northern Cape Province has a dependency ratio of 55.7, compared to South Africa's average of 52.7. This means that in 2011, in South Africa, every 100 persons of the economically active population (ages 15–64) were expected to economically support 52.7 dependents of whom 44,5 were children and 8,2 were adults. In SPM, of every 100 productive persons, the expected burden is 51 dependents, which is extremely high.

TABLE 4.1: SOL PLAATJE MUNICIPALITY DEMOGRAPHICS

Category/Variable	Quantity / Percentage (%)
Total SPM population	248 041
Galeshewe Population	107 920
Young (0–15 years)	28,3%
Working (16–64 years)	66,2%
Dependency ratio	51
Unemployment rate	31,9%
Youth unemployment rate	41,7%
Higher education (aged 20 years+)	10,4%
Matric (20 years+)	29,2%
Number of SPM households	60,297
Number of Galeshewe households	25,429
Formal dwellings	81,6%
Flush toilet connected to sewage	82,8%
Weekly refuse removal	84,3%
Piped water inside dwelling	61,9%
Electricity for lighting	84,9%

Source: Adapted from StatsSA (2011)

There are generally low levels of education in SPM, and especially for higher education which was at 10,4% for those aged 20 years and above. SPM exhibited high levels of municipal services (sewer connections, refuse removal, piped water inside dwellings and electricity for lighting) provided to households, which was 78,4%, and at 81,6% for formal dwellings. Electricity for lighting was at the highest at 84,9%, which is an indication of high access to energy, particularly for lighting.

4.2.1 Population and educational levels

Figures 4.1 to 4.3 show the population and educational levels, while Figures 4.4 and 4.5 show employment and income levels for SPM.

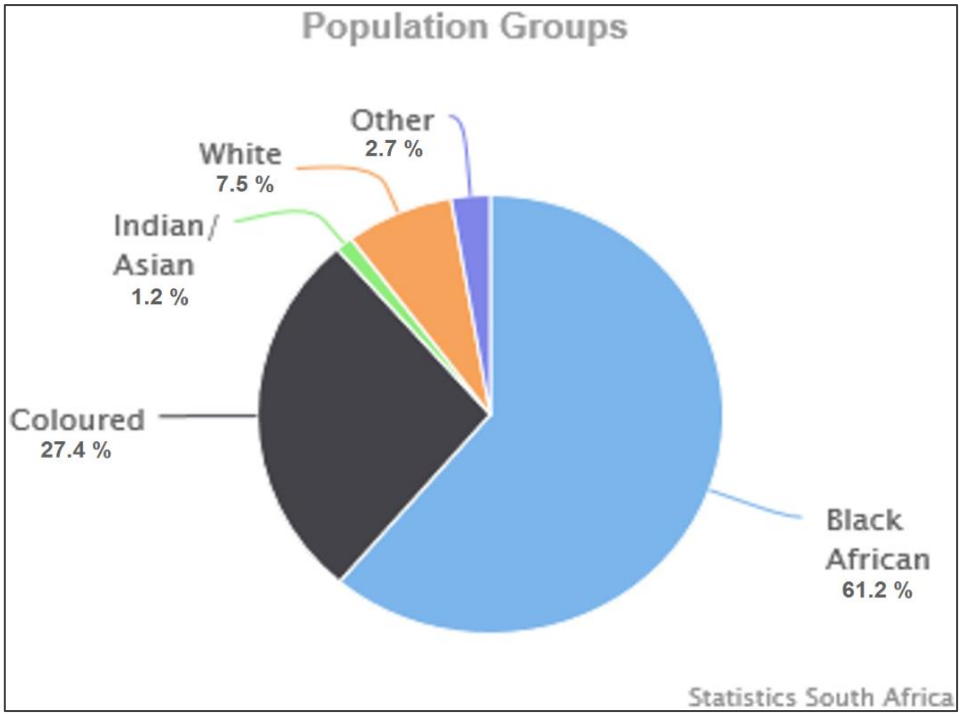

Figure 4.1: Population groups of the Sol Plaatje Municipality (StatsSA, 2011)

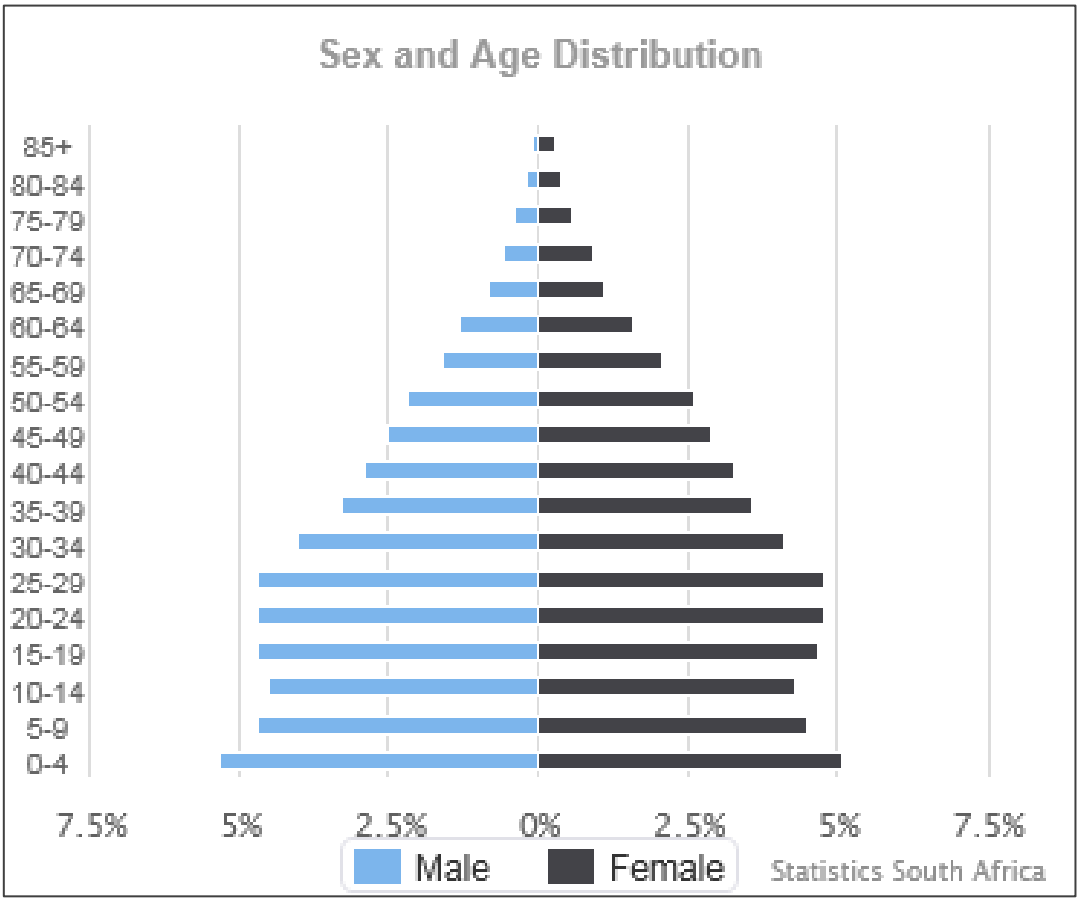

Figure 4.2: Gender and age distribution for Sol Plaatje Municipality (StatsSA, 2011)

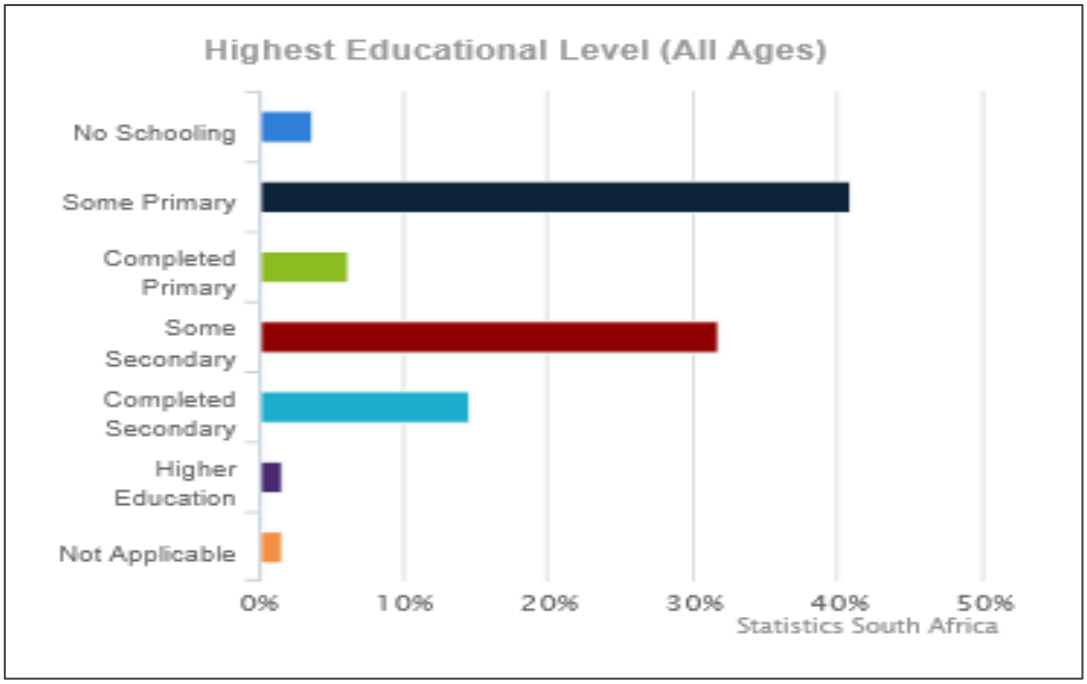

Figure 4.3: Educational levels for Sol Plaatje Municipality (StatsSA, 2011)

Based on the chart in Figure 4.3, 41% of the population of all ages had some primary education and 32% had some secondary education, while 14% completed secondary education. Those with higher education comprised a mere 1%. Based on the understanding that education levels have direct bearing on income levels, as well as the skills one is likely to possess, and overall quality of life, the majority of SPM population did not possess skills that could allow them to earn adequate income and would hence be expected to remain within the indigent-households category.

4.2.2 Income and employment

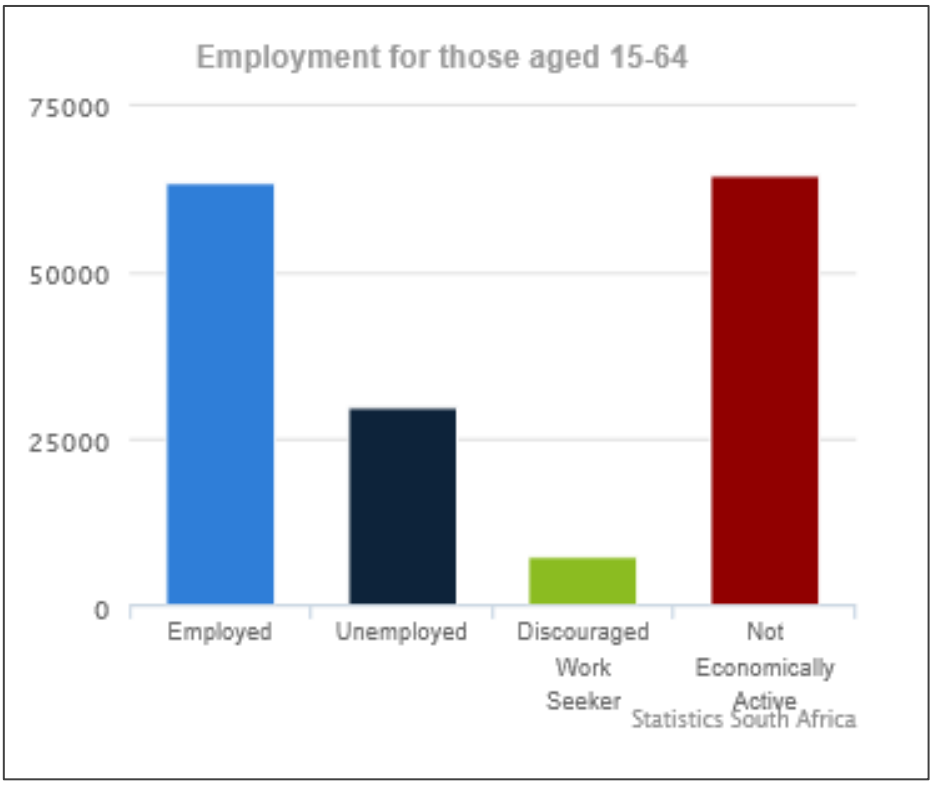

Figure **4**.4: Employment levels of Sol Plaatje Municipality (StatsSA, 2011)

Based on the data presented in Figure 4.4, the number of those who were employed was almost equal to those who were not economically active. This pattern poses a major risk in the long run as a growing number of the population fell in the category of “not economically active”.

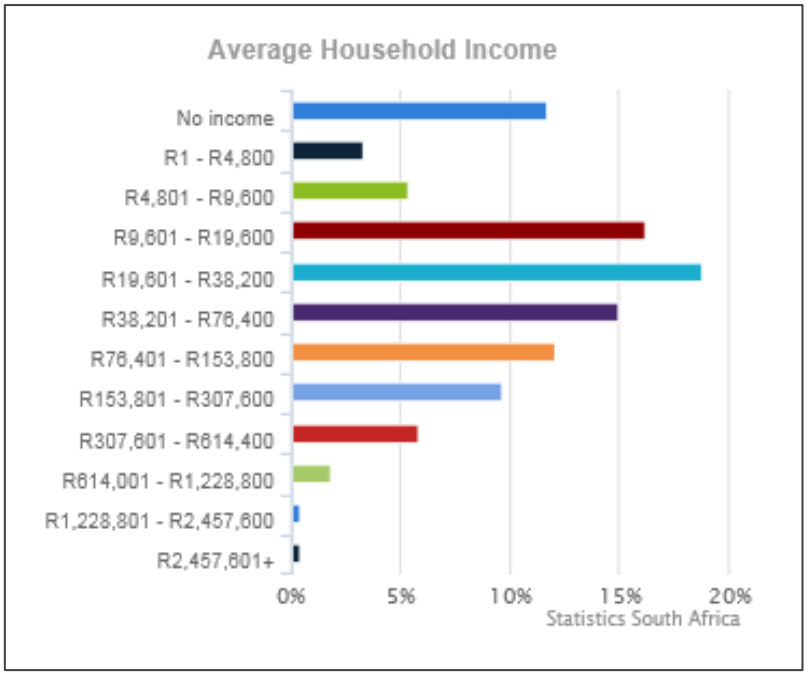

Figure 4.5: Average annual household income in Sol Plaatje Municipality (StatsSA, 2011)

With regard to average annual household income, those who work earn little (Figure 4.5). A monthly household income of R3 500 (the definition of “indigent”) equates to an annual income of R42 000. According to Figure 4.5, at least 55% of households in SPM earned less than this, with around 12% of households having no income at all.

4.2.3 Demographics implications

The high dependency ratio and high proportion of indigent households may have significant negative impacts on sustainable payment for municipal services, thus contributing to reduced municipal revenue. This would impact negatively on the provision of subsidised municipal services and revenue stability.

As the SPM provides high levels of services to all its consumers, including the indigent households, in future these services would require maintenance, which implies high ongoing costs for the municipality. The municipality therefore needs to find a way to sustain and enhance service delivery while remaining financially viable over the long-term. In future, these formal households will fall under the current cohort of adults, and with the current high youth unemployment, their ability to pay for municipal services is anticipated to be either low or non-existent, thus resulting in

an ever-increasing number of indigent households wholly dependent on the municipality for subsidised services. It is important to note that this will translate into an escalating problem for all municipalities as they attempt to improve their service delivery levels, while at the same time are faced with escalating costs as well as numbers of deserving households.

4.3 Data analysis on grant funding and related implications

This section presents and analyses data on the current funding and business model for provision of electricity within SPM as the case study municipality. The government provides for electricity to indigent households mainly through national department grants and direct municipal grants. It would therefore seem that there is already dependency by one sector of the population (indigent households) on another sector, which is the government. Government grants make provision for electricity in both formalised and established settlements, as well as in new connections in new low-income human settlements.

The SPM receives an ESG from the National Treasury annually for own operational expenses including provision for FBE and other basic services for indigent households such as water, sanitation and refuse removal. FBE is a subsidy meant for electricity provision to indigent households. SPM purchases bulk electricity from Eskom for distribution to consumers in its jurisdiction, including indigent households. Of importance to note is that there are 13 654 registered indigent households and the municipality has more than the registered number of households who fall within the indigent household status. The number of registered indigent households has direct bearing on ESG allocation from the National Treasury. Should more qualifying indigent households register, increased allocation from National Treasury would be solicited.

In 2015/16 the SPM's budget for purchasing electricity from Eskom was set at R400 million, with R12.5 million allocated for FBE, which translates to 3.1% of the total municipal electricity budget. As confirmed by manager C (a respondent), the monthly allocation to each indigent household was R67.00 per month for FBE for 50 kWh at a tariff of R1, 33/kWh. This monthly allocation proves to be too low and forces indigent households to supplement energy needs from their own income. The

same sentiment was echoed by manager C that the current allocation of 50kWh needs to increase, stating that “ideally it should be 150kWh phased-in”, i.e. to be implemented by the municipality on an incremental basis from the current 50kWh. His assertion is in line with Prasad and Ranninger’s (2003) argument of improved access to energy as elaborated in Section 2.4. Palesa (household respondent) also confirmed her unhappiness on the amount her household spends to purchase electricity and quantity of electricity units received, stating that “No, units are less. There is insufficient electricity for about three weeks”. Neo (another household respondent) emphatically responded that “No, it’s too much” referring to the cost of electricity.

Indigent households are required to self-select and register on a municipal database in order to access FBE of 50 KWh to which they would be entitled, and only once their application is verified and approved by the municipality can they be validated as indigent households. They can only access FBE through claiming a monthly token, either from the municipality or from municipal electricity vendors distributed throughout the city.

Accessing FBE by indigent households has not been without challenges. For example, four of the five households interviewed reported that they were uncertain about accessing FBE and hence they purchase electricity monthly without any free electricity units provided, implying that they do not access FBE even though they are validly recognised as indigent households. A similar sentiment was echoed by manager D who confirmed that not all indigent households claim their monthly FBE tokens. This indicates an urgent need for the SPM to address the matter: poor communication and an awareness-gap on FBE opportunity for potential beneficiaries are evident. Forfeiture of FBE monthly tokens equates to savings by the municipality. As mentioned by manager C, SPM has fewer registered indigent households. However, Equitable Share Grant (ESG) allocation towards FBE takes into consideration total registered indigent households and would therefore influence overall municipal ESG and FBE. There is also a correlation between budget allocated towards FBE and registered indigent households.

The current business model for municipal provision of electricity nationally, including budgeting and revenue accrued from municipal sales, needs re-engineering. In

response to a related interview question for SPM, manager B indicated that although electricity's rand value had increased, the volume of electricity sales was declining. The respondent attributed the decline primarily to lack of affordability as households are now generally using electricity sparingly and, overall, consumers are now conscious of their patterns of usage. Indigent households interviewed stated that electricity is expensive and purchased units do not last for long. Some of them have opted for alternative energy sources such as candles, paraffin and sometimes wood and kerosene.

The Department of Energy (DoE) is another key funder for municipal electricity infrastructure for low-income households, as well as RE technologies. With regard to new developments for low-income human settlements, the DoE, through the Integrated National Electrification Programme (INEP) as a once-off grant, provides capital costs for electricity infrastructure connections to such households. For new connections on greenfield sites, the allocation stands at R11 500.00 per connection (2015/16 financial year), whereas for infill housing connections (developments in vacant areas within the existing settlements), the allocation stands at R3 900.00 per connection. Although these grant allocations are once-off, there is an increase annually. In addition, the DoE also funds conversion of lights to light-emitting diode (LED) energy efficient lights to compensate for cost escalation. This is a significant opportunity that could be explored for the benefit of indigent households. In 2011, the DoE funded the installation of 7 873 SWH in low-income households within SPM at a cost of R54 million**.** Indigent households' experiences with regard to the SWH installation are elaborated in Section 4.5.

Thus, in its current form, the business and funding model for indigent households is through a perpetual ESG for FBE for recurrent costs, as well as a once-off INEP for capital costs. The main government role players are National Treasury and the DoE as well as the SPM in this instance, through providing a top-up budget on electricity infrastructure provision. Since the SPM provides indigent households with a high-quality electricity service at 60 Amp instead of the national norm of 40 Amp, it then tops up on the difference in cost relative to the level of funding by DoE (INEP). Since the quality of electricity provided is higher than usual for indigent households,

operational, personnel and maintenance costs are also higher and thus constitute a higher cost-burden for SPM.

Costs continue to escalate within the indigents' electricity provision value chain, especially as costs to purchase bulk electricity from Eskom escalate annually and operational and maintenance costs increase. According to manager D, these costs continue to rise, while at the same time income from electricity sales decreases "as big electricity users are into solar (with the Gariep MediClinic and some malls as key examples in SPM)". Other risks linked to the current electricity system that emerged during interviews with municipal personnel are overloading of the system, illegal connections and extensions, as well as improper use of electricity which may result in injuries and/or fatalities. One critical mitigation factor mentioned for these risks is upgrading of insufficient electricity infrastructure that was installed prior to 1994. Such upgrading would open up significant opportunity for the SPM as it could allow for factoring in installation of solar energy as part of the upgrade options.

As mentioned in Section 1.1, these rising costs will translate into an increasing cost burden for the municipality, in perpetuity, which is unsustainable. Equally, the perpetual dependency on ESG for FBE for an increasing number of indigent households, further escalates the dependency risk on the national government. It is therefore critical that this unsustainable cycle is mitigated through alternative and innovative models.

4.4 Costs linked to electricity provision

There is a range of costs that must be considered for any viable and sustainable finance and business model that could allow indigent households and the municipality to benefit from RE. Costs are linked to the infrastructure outlay which would include meters that would accommodate solar electricity, and smart-net metering equipment in instances where consumers are to feed surplus electricity into the municipal grid and claim as envisaged under the prosumers concept (consumers who transition to becoming producers of electricity at the same time).

Within existing settlements, additional costs could be confined to replacement of analogue meters as current cabling and general infrastructure would already be in

place. For new low-income settlements, the guaranteed electricity infrastructure grant – INEP – could be used for general infrastructure, including solar compatible smart meters. The interview response from manager D confirmed that the current cost of a smart meter which accommodates a solar PV generator would vary between R4 000.00 and R6 000.00 per four-quadrant smart meter. Thus, the SPM may be required to budget once-off to replace non-compliant meters in existing connections for low-cost housing. This cost could be estimated at 13 654 indigent households × R6 000.00 = R81 924 000.00. The minimum cost would be 13 654 × R4 000.00 = R54 616 000.00. Manager D further confirmed that the main cost associated with converting to solar by existing low-cost housing, was the cost of a smart/net-metering meter which would have to be carried in full by the municipality as an upfront once-off cost.

As mentioned earlier, for new settlements, the INEP grant together with SPM's top-up funding, could be used to provide generic electricity infrastructure as well as smart meters. As presented in Section 4.3, the Department of Energy (DoE-RSA)'s INEP grant allocated R11 500 per new connection in the 2015/16 financial year and the allocation increases annually. Costs under this scenario would therefore be lower in comparison with the replacement scenario discussed above.

4.5 Data analysis on access to electricity – indigent households

As noted in earlier sections of the study, each validly registered indigent household is entitled to 50 kWh of FBE monthly. Primary data gathered from the five indigent households interviewed showed that four of the five households were not aware of FBE and the process for accessing it. Other indigent households' concerns were mainly on insufficient and expensive electricity they purchase regularly, which totals to between R100 (75kWh) and R500 (376kWh) per month. As mentioned in Section 4.3, the cost of 50kWh FBE is R67 per month, an amount that is marginal when compared to what indigent households pay to top-up electricity once FBE-provision is depleted.

The interview responses indicated that on average an indigent household with a monthly income of R1 500 spends at least 28% of their monthly income on electricity and other alternative forms of energy such as candles and paraffin. Inclusively, for all

the basic municipal services – electricity, water, refuse removal and rates – each indigent household spends on average 42% of their monthly income compared to the more reasonable 12% as per the middle-income households (Sugrue and Lebelo, 2009). This finding is confirmed by municipal primary data which reflects less funding provided by the municipality through FBE at R67 per indigent household per month, as well as a high percentage spent by households towards energy. Although the electricity service at 60 Amp reflects a higher quality than usual for indigent households, the volume of consumption remains low relative to a household's needs. Primary data from the indigent households therefore supports the literature that suggests that 50kWh is insufficient, and also supports Prasad and Ranninger's (2003) argument for improved access to energy as elaborated in Section 2.4. With regard to insufficient electricity provided as well as the need to improve access to energy, there is coherence between literature reviewed in Chapter 2 and primary data from municipal respondents and indigent households.

The following average figures were obtained from the indigent households interviewed: An indigent household of five pays at least R430 for energy (electricity, candles, paraffin), which on average is composed of R300 for electricity, R30 (at R10/packet of candles) + R100 (at R10/litre for paraffin) = R430. This amount excludes an average of R200 of rates/'rent' per month. According to responses from Manager C, rates/'rent' refers to rates, refuse removal, sanitation and water. Primary data from households also indicate that all interviewed households use candles as an alternative energy source for lighting, but the duration of usage varies between 'sparing usage' to 'daily usage' such as when cut-off or load-shedding takes place. Due to an unacceptably high percentage (28%) cost of electricity for indigent households, levels of consumption decrease due to lack of affordability as households use it sparingly and households become increasingly conscious of their usage.

Suppressed demand is also clearly evident from the primary data collected from indigent households. The purchase and consumption patterns as well as the quantities of all energy types consumed, indicate under-consumption of energy services. This scenario can be reversed if electricity supply were to become more accessible and affordable. As discussed in Chapter 1, budget constraints are some

of the factors that prevent indigent households from moving to higher levels of utility thus resulting in varying levels of suppressed demand. Respondents from all five households expressed suppressed demand in that they do not have or regularly use all electrical appliances they would like to if they had increased access to affordable electricity. The appliances mentioned include washing machines, toasters, a stove with an oven, security lights, vacuum cleaner, hair dryer and heater.

Suppressed demand indicates insufficient access and use of electricity which then limits the lifestyle options of such households and hence their well-being or quality of life. At a stage when indigent households gain access to affordable electricity that would allow more choices for households, more appliances would be utilised, thus mitigating suppressed demand. That would mean increased demand for electricity. For indigent households, suppressed demand can be primarily attributed to limitation of choices. On the other hand, it would mean the municipality would be required to spend more on energy supply to the households, thus resulting in high energy and related input costs.

Primary data gathered from households also demonstrate an unsustainable cycle of deterioration in affordability, limited access to electricity, suppressed demand and general poor quality of life. Perpetually rising costs coupled with increasing uncertainty on income emerges strongly for both the municipality and indigent households. Both are caught in a cycle that calls for urgent alternative and innovative business and funding models for both provision of electricity by the municipality, as well as improved access to electricity by indigent households.

The motivation for a transition to solar energy by households is based on the opportunity for cheaper electricity supply with no perpetually increasing costs, whereas for municipal personnel, there are key concerns about the high costs of RE infrastructure installation and cost of maintenance post-installation stage. Indigent households anticipate affordable costs, while the municipality anticipates high installation and maintenance costs. Based on this, there is a clear contradiction of expectations and interests with regard to the cost of RE (solar) between indigent households and municipal personnel respondents. There is therefore a need to reach common ground in order to bridge the interests of indigent households and

those of the municipality. That could be addressed through an innovative business and funding model for the initial as well as operational costs.

4.6 Household experiences of current renewable energy technology

Primary data on individual household experiences with currently installed RE technology in the form of SWHs, commonly referred to as solar water geysers, were gathered from indigent household respondents. One of the criteria for indigent household selection for the interviews was that it must have a SWH system installed. Four of five household respondents confirmed that the installation of SWH has had a positive impact on their livelihoods as it improved their quality of life and reduced their household expenditure on electricity costs. Linda said: "Yes, it has, am happy about it. It wastes water though" (since the geysers are bigger than the usual household kettle used to warm water). Based on other general comments on SWH, it emerged that SWH were not servicing the indigent households optimally because SWH provided hot water in summer and lukewarm water in winter. This is not ideal in winter when hot water should be regularly available.

As confirmed by interview responses from manager D, the installed systems are low pressure SWH. Further research could be conducted with regard to low pressure SWH and their appropriateness for the hot water needs for indigent households. Low pressure SWH are regarded as lacking pressure, are a cheaper product when compared with high pressure SWH, are inferior and are of lower quality (Green Energy Solution, 2017).

Three of the five households were of the view that their electricity bills have decreased after SWH installation by approximately R100 to R200 per month, which ranges between 33%-66% bill reduction per month. One interviewee stated that "I used to pay approximately R300 per month" and currently she pays between R100 and R200 per month. Three of the five households also confirmed willingness to consider shifting to solar electricity should they be given this alternative. They cited different reasons for their openness to the opportunity, including: "If it is going to reduce the current bill..."; "because it would be free electricity"; "we'll save more on solar than we normally do..." Of interest were the views of the other two respondents: one could not consider converting to solar because she did not know about it; and

the other one would not necessarily convert to solar because of cool weather in winter which might have a negative impact on energy received from the sun, resulting in unavailability of energy/electricity and she did not want to take such a risk. This respondent further noted that only if solar and conventional electricity were to be integrated, would she consider the solar option. This respondent thus raised additional issues such as access, consistency, convenience, and affordability. This underlines the expectation that electricity service, with whichever technology, must adhere to these criteria as well.

4.7 Municipal officials' views on renewable energy technology

Primary data gathered from municipal employees clearly indicated that some thought has gone into RE and the role of the municipality, particularly regarding the dawn of conversion to solar energy by ‘big’ users and in municipal public spaces. Manager D confirmed that a draft policy on solar PVs was in place and now awaiting final approval, and amongst its areas of focus is to introduce a basic monthly fee to solar PV users in order to “recover some losses”. Installation of smart metering, as well as reimbursement of consumers for feeding electricity into the municipal grid, are some of the areas that the municipality is considering. Once the policy is approved by Council, its implementation could be endorsed and effected. The SPM is closely monitoring implementation of electricity by-laws, including assessment of technical and safety compliance, registration of consumers with solar PVs installed as required by NERSA, as well as keeping a database of applicants. This is how far the SPM currently goes with regard to its role in RE transition.

4.8 Conclusions

Access to affordable electricity remains a challenge as the situation is currently resulting in exclusion of indigent households from the electricity and energy space. The status quo is unsustainable and costly, and the monthly 50kWh as part of FBE is validated through primary data to be insufficient for those who access it. The monthly cost of electricity places a high burden at an average of 28% per month for a household with a monthly income of around R1500. This is higher than the commonly acceptable norm of 12% for urban indigent households (Sugrue and

Lebelo, 2009). In addition, a key finding based on the analysed data indicates a high dependency ratio in terms of demography, high dependency on municipal basic services by indigent households, high energy costs that are borne by indigent households as well as high energy provision costs borne by the SPM. This is an unsustainable situation. There is generally a positive outlook on shifting to RE by both the indigent households and the SPM.

Based on the analysis, it becomes critical for municipalities to explore alternative funding and business models using government grants and funding, especially ESG/FBE and INEP. Improved household access to electricity, especially through enhanced long-term affordability, is crucial for the indigent households, and this could be greatly enhanced through government funding supplemented with additional funding from complementary sources.

The next chapter addresses the second research question on innovative funding and business models that could allow both indigent households and the municipality to benefit from RE. The prevailing suppressed demand by beneficiary households has to be taken into consideration when exploring such innovative business and funding models.

Chapter 5

Innovative funding and business model for household and municipal benefit

5.1 Introduction

This chapter analyses data related to the second research question which seeks to identify innovative funding and business models that could allow both indigent households and the municipality to benefit from a transition to renewable energy technologies and services. Data used to answer this question included primary data gathered from municipal personnel and indigent households, as well as secondary data from various sources as described in Chapter 3. A sustainable, innovative funding and business model has to be put in place so as to redress the status quo described in Chapter 4. Critical fundamental factors in such a model include improved access to affordable electricity, financial contributions by government, sustainable and affordable operations and maintenance of the system. This chapter provides analysis of options for reconfiguring the current funding model, building on the foundation provided in Chapter 2. All the elements of the proposed new model are then drawn together and presented in Chapter 6.

5.2 Options for electricity provision

As shown in the previous chapter, the cost of electricity provision by the municipality is high, notwithstanding that the benefit by indigent households from such high input costs is low. Three main government sources of funding for electricity provision were discussed in Chapter 4, namely ESG through FBE as well as an INEP. These government sources were coupled with the municipality's direct or indirect financial contribution. Direct financial contribution is in the form of top-up funding for electricity infrastructure provision, whereas indirect financial contribution comes through personnel and infrastructure maintenance costs. Currently, Eskom sells bulk electricity to SPM, who in turn sells to the consumers. As a licenced distributor of electricity, the SPM distributes it through its network and sells to consumers at profit. Profits realised through resale of electricity accrue as one of the main sources of

revenue for the municipality for its own operations. This poses risks on municipal revenue in instances where electricity sales decline. The SPM owns the electricity distribution network in its municipal area, including cables, transformers and sub-stations. Commissioning, installation and maintenance of these systems are the full responsibility of the municipality.

One alternative to this government-driven model is a private sector driven model whereby the private sector takes the lead for electricity provision. As discussed in Chapter 2, iShack is a community sector driven model that aims to provide access to affordable electricity in informal settlements. The iShack project demonstrates how consumers could also contribute through purchasing electricity and carrying out maintenance services, notwithstanding the fact that they have to pay towards the purchase of the portable solar home system (called DC Multigrid) which can be upgraded according to household needs. The iShack system is underpinned by a business model that has the end-user as a contributor based on affordable user payments. It entails a component of fee-for-service and pay-for-service by the end users. iShack gives an opportunity for households living in an off-grid informal settlement to access electricity at what could be an affordable cost.

The basic level of the DC Multigrid system includes two indoor lights, a cell phone charger and an outdoor motion activated security light (Keller, 2012). At this basic level, it aims at replacing paraffin and candles while also offering an opportunity for incremental upgrading. The cost of a DC Multigrid core unit is R3 625, as per 2012 prices. With an assumed annual 10% increase in prices, in 2017 this could cost about R5 807. Although this model is community sector driven, there is some form of participation by the municipality. However, a clearer view of the municipality's role to date on iShack calls for further research which falls outside the scope of this study. This is primarily because the iShack model focuses on informal settlements and not on formalised low-income housing as prioritised in this study. As a result, the relevance to the households in low-cost housing may call for multiple adaptations. Some of the risks identified in relation to the sustainability of the model range from non-payment for the system by end-users as well as for energy consumption and for the maintenance of the system. Based on readily available secondary data, the iShack's long-term sustainability has not been adequately evaluated as yet.

Another form for electricity provision as part of a finance and business model could be where emerging entrepreneurs provide solar home systems through their own means, whilst users pay for the system and service over time. In addition, electricity provision to indigent households could be in the form of a PPP between government, the community, as well as private sector partners. Under this scenario, in a manner similar to the iShack model, the private sector invests in infrastructure such as solar PVs or mobile/portable solar home systems. The private sector could install, maintain and lease out to individual households within a model that mitigates for the inherently higher risk associated with serving this specific market segment. Under all these alternative models, consumers would be expected to have some level of contribution, with government being a complementary role player (rather than the primary one) in the entire value chain.

In addition to the above models, another consideration is the location of the solar plants where the level of decentralisation would be the key issue. In the interviews with municipal officials, manager C expressed strong views in support of neighbourhood plants that service individual neighbourhoods as well as PPPs where the private sector provides, installs and maintains the infrastructure, while the government/municipality serves as a regulator to ensure that interests of the indigent households are consistently prioritised. Feasibility studies, as well as additional research, would be required in order to ascertain the viability of neighbourhood solar electricity plants. Should a municipality opt for decentralisation of plants, it has an obligation to provide suitable land and its role would remain that of a shareholder.

Other considerations on the provision of RE to the indigent households are awareness campaigns, aftersales training, basic operations and maintenance at household level. All these roles/responsibilities come at a cost that the municipality and private sector actors must budget for. During face-to-face interviews with manager E, it emerged that one of the risk mitigation factors for improper usage of electricity by indigent household users is through education and awareness campaigns on more efficient and safe ways of using electricity.

5.3 Costs of transition to RE

According to the SPM Final Adopted Budget 2016–2017 as presented in Table 5.1 for the 2015/16 financial year, the electricity budget for operational repairs and maintenance (material only), was R22.631 million. The budget for labour costs as part of overall maintenance was R20.435 million. There is an additional R14.055 million budgeted for personnel costs. Overall total costs for operations, maintenance, labour and personnel is R57.117 million. This was budgeted for one financial year (2015/16) and escalates annually. These input costs are for the entire municipality with 60 697 consumers. Operational repairs and maintenance budget include indirect expenditures which are remuneration, purchases of materials and contracted services. This amount is in addition to R400 million bulk purchases to Eskom. R12.5 million of that is allocated to FBE. Thus, a total budget injection towards electricity provision by the municipality for all its consumers in the 2015/16 financial year is in the region of R457 million, which is approximately 27% of the overall municipal budget of R1.7 billion.

TABLE 5.1: ELECTRICITY BUDGET AND EXPENDITURE

PRELIMINARY RESULTS FOR 2015/16 – ELECTRICITY DEPARTMENT				
No	**Description**	**Original budget**	**Adjustment budget**	**Year to date actual**
1	Electricity maintenance 2015/16 (Material only)	22 709 000.00	24 238 000.00	22 631 069.08
2	Electricity maintenance 2015/16 (Labour costs only)	2 067 217.00	20 067 217.00	20 435 592.86
3	**Total maintenance expenditure**	**42 776 217.00**	**44 305 217.00**	**43 06, 661.94**
4	Personnel cost excluding maintenance labour costs	12 901 781.00	12 901 781.00	14 055 728.55
5	**Total**	**55 677 998.00**	**57 206 998.00**	**57 122 390.49**

Source: (SPM, 2016:46)

Based on Table 5.1, the annual aggregate operational input costs (personnel, general maintenance, materials) towards indigent households are in the region of R12.7 million, which is based on the following calculation:

R57 million
60 697 municipal households
= R940/household × 13 564 indigent households
= R12.7 million
= R940/12 months
= R78 per indigent household (electricity provision costs)

This translates to R78 operational costs per indigent household per month, a cost higher than the monthly R67 FBE subsidy per beneficiary indigent household. The annual FBE allocation is R12.5 million, whilst operational input costs and costs of supply are approximately R12.7 million. The data demonstrates that in its current form and model the cost of provision of electricity to indigent households is high. Thus, overall direct costs towards indigent households for electricity provision and associated personnel/maintenance and supply costs that the SPM allocated in 2015/16, was approximately R25.2 million. This translates to a rounded cost of R150 that SPM spent per indigent household per month, i.e. R67 (FBE cost for 50kWh) + R78 (electricity provision costs). These are all guaranteed input fixed costs which the SPM would always have an obligation to incur in the 2015/16 financial year and would keep increasing annually. Input costs are higher (R150) when compared to output of 50kWh electricity.

It can be concluded that the value of input costs for electricity provision for indigent households is higher than the value of output yielded, namely the benefit of sufficient FBE is not realised despite the high investment by the municipal and national government. In support of this assertion, manager B's view was that "… big portion of cash flow is decreasing gradually. Expenditure costs are fixed, that is maintenance of electricity lines and personnel costs but basis for income is low". Variable/fluctuating costs are mainly costs associated with the purchase of electricity at bulk from Eskom. Once the SPM shifts to RE (solar) for this consumer market, the costs of purchasing the related proportion of electricity from Eskom would be reduced. Investment and shifting to RE by municipalities would result in cheaper

future bulk purchases (Vermeulen, 2017). Other positive traits linked with shifting to solar energy, as mentioned by manager D, are “reduced or at least capped future electricity tariffs to consumers as there won’t be pressure to purchase more bulk and to subsidise indigents.”

Even though it could be argued that these are very basic calculations compared to the thorough modelling needed to enable estimated costs of electricity provision to indigent households, the process and numbers serve as useful guides to the SPM’s current financial model for electricity provision to indigent households.

Table 5.2 below provides a synopsis of quantitative information within the electricity provision value chain which has to be taken into account when recommending innovative funding and business models that could allow both indigent households and the municipality to benefit from RE transition.

TABLE 5.2: COST IN THE ELECTRICITY PROVISION VALUE CHAIN

Variable	Amount (R)
Total indigent households	13 564
SPM annual budget for Eskom bulk electricity	R400 million
SPM annual budget for indigent households	R12,5 million
SPM annual general operation costs (indigent households)	R12,7 million
FBE – 50 kWh	R1,33/unit
Cost of a smart meter (minimum)	R4,000
Cost of a smart meter (maximum)	R6,000
INEP – new developments per connection	R11,500
INEP – infills per connection	R3,900

Source: Compiled from primary and secondary data

5.4 Renewable energy technology options for low-income households

Given that the choice of any RE technology entails related cost, it has direct bearing on the ultimate cost of electricity to indigent households. Transitioning to RE calls for a critical consideration of the type of technology to be used, as well as its long-term durability and sustainability. In addition to the costs associated with replacement of current meters with smart meters, one needs to factor the costs of the appropriate home solar system that indigent households are likely to afford. Other costs could be linked to installation of solar PVs on the roofs of houses for the indigent households, should that be the preferred option.

Table 5.3 provides an overview on the costs of various technologies sourced from normal retail outlets as well as from online sources.

TABLE 5.3 OVERVIEW ON THE COSTS OF VARIOUS TECHNOLOGIES

Technology	Cost / (R) incl. VAT	Output (kWh)
Grid-Tied solar system OR Hybrid solar system	R24 000 – R28 000 (no battery) R34 000 – R40,000 (with battery)	Calculation based on targeted 150kWh per month / 6kWh day
Sustainable 1.5 kWp Microcare Grid-Tied Solar Power Kit	R47.659	6kWh per day (1 800kWh per year)
Sustainable 1.5 kWp Grid-Tied System Solar Power Kit	R34.216	2 214.50kWh per year
Sustainable 1.5 kWp Grid-Tied Battery Back-up System Solar Power Kit	R67.000	3 221.50kWh per year

Source: (Sinetech, 2016)

Secondary data gathered give an insight into current costs of various mobile RE technologies for indigent households in an instance where a municipality opts for these. Important considerations with regard to technology options and costs would

be the current 50kWh monthly FBE allocation (which translates to 600kWh/year); as well as the call for this to be increased to 200kWh/month (which translates to 2400kWh/year). According to Sinetech (2016), there are different kinds of PV solar systems, namely stand-alone, grid tied and grid interactive. Stand-alone systems are typically used for scenarios where the grid connection has not been implemented and can be installed practically anywhere. In contrast, grid tied systems do not require backup batteries, but would instead be connected to the conventional grid and could therefore be expandable. Eskom, or similar relevant authorities, have to approve the system. Grid interactive systems entail a backup system with a battery storage and additional controls which are generally more costly, compared to the cost of a grid tied system, but are also expandable.

As highlighted in Chapter 2, in any choice of RE technology cognisance of climatic conditions of an area is key. Considering that the study area, Kimberley, is located in an arid region with very cold winters and very hot summers, it becomes important that these conditions are included in RE technologies chosen. As an example, technology meant for cooking can also perform as an air conditioner, and a cell phone charger can be combined with a television or any other appliance.

5.5 Funding model for transitioning to renewable energy

As discussed in Chapter 2 and summarised in Table 5.4 that follows, there is a diverse range of funding source options for transitioning to RE, especially for solar. However, this section focuses on secondary data analysis stipulating options regarded to be the most feasible towards facilitating the needed change, especially by allowing both indigent households and the municipality to benefit from the transition to RE. Government funding, climate-change linked finance, private sector and users remain key pillars as funding mechanisms to achieve inclusivity of cities through the promotion of RE for the indigent households.

TABLE 5.4: SYNOPSIS OF FUNDING SOURCE OPTIONS FOR A NEW FUNDING MODEL FOR SPM

Funding Source	Purpose
Government – National Treasury	▪ Equitable Share Grant (ESG) for Free Basic Electricity (FBE) ▪ Backcasting of ESG linked to the Medium-Term Revenue and Expenditure Framework (MTREF)
Government – SPM	▪ Top-up funding on INEP grant ▪ Use of SPM's internal electricity personnel to implement RE initiatives ▪ Energy policy approved by Council ▪ Effective town planning processes underpinned by high densities ▪ SPM incentives for RE investments
Government – DoE-RSA	▪ INEP grant ▪ DoE funding for conversion of lights with LED energy efficient lights ▪ DoE through Central Energy Fund (CEF) for promotion of SWH ▪ Implementation of Clean Developmental Mechanism (CDM) through DoE
Government – DEA-RSA	▪ Green Fund managed by DBSA ▪ DBSA's funding role includes green bonds, loans, equity
Climate-change finance	▪ International Council for Local Environment Initiatives (ICLEI) through Urban Low Emission Development Strategies (Urban LEDS) to promote transition to low emission urban development and for capacity building for local government, including South Africa's selected municipalities, for example the SPM ▪ Clean Development Mechanism (CDM) ▪ Certified Emissions Credits (CER) ▪ Carbon Finance
Private sector	▪ PPP solar manufacturing plant ▪ Corporate Social Investment linked to the Renewable Energy Power Producers Procurement Programme (REIPPP) ▪ Social Labour Plans (SLPs) linked to mining houses ▪ Philanthropic investments
Users' contribution	▪ Personal individual savings ▪ Stokvels
Capacity building and training	▪ Foundation of the German Technical Corporation(GIZ) ▪ Council for Local Environment Initiatives (ICLEI) ▪ The South African Renewable Energy Technology Centre (SARETEC) ▪ Energy Sector Education and Training Authority (ESETA)

Based on secondary data

For an effective shift to RE on the basis of guaranteed FBE funding, the municipality could use backcasting of future FBE budget allocation to current funding and utilise such funds as a financial base for shifting to RE. Backcasting is a planning method that starts with defining a desirable future and then works backwards to identify policies and programmes that would connect the future to the status quo (Ebert et al., 2009). It approaches the challenge of influencing the future from the opposite direction. Such backcasted FBE could be within the municipality's legal three-year planning cycle – Medium-Term Revenue and Expenditure Framework (MTREF) – thus bringing forth a three-year FBE budget. For example, R12,5 million as confirmed by manager B for FBE in the 2015/16 financial year, at 7% annual escalation for three years – which is the municipality's acceptable norm for escalation costs of services – would be a sum of R43 million which is guaranteed. For backcasting to succeed, the municipality must submit a written motivation to National Treasury for early release of funding. With good motivation, and clear demonstration of core and co-benefits, it is possible to access the funding which could then be used as a base for either partnering with the private sector for RE promotion or for an internally driven programme on RE promotion to indigent households.

In a scenario where the municipality adopts an approach of internal implementation for RE promotion, it can use its own pool of electricity personnel for whom it already carries salary costs and in that way savings on personnel costs can be realised. Instead of hiring RE qualified electricians at a cost, the municipality could retrain existing electricians on RE thus saving on potential additional personnel costs. The municipality's strategic planning becomes very important towards realisation of inclusive cities with affordable and accessible RE to indigent households as per the research question. Such strategic planning could convince potential funders on the long-term municipal commitment to develop a clear business model for RE where indigent households and the municipality would be the primary beneficiaries.

Another guaranteed funding source is the INEP grant of the DoE. Again, this is guaranteed funding based on submission of business plans by a municipality to the DoE once there is a proclaimed township through town planning processes. It thus becomes crucial that for municipalities to access the INEP grant, its town planning

department must continuously prepare land for the development of integrated human settlements which must include housing for low income households. In that way, INEP funding can form a base for overall electricity infrastructure connections for the entire integrated human settlements.

Readiness of municipalities for such future developments would be crucial, particularly in the wake of high urbanisation rates now facing most municipalities in the country. This is also a challenge now facing SPM as confirmed by primary data collected through a semi-structured interview with manager A, who highlighted the challenge of increasing urbanisation coupled with increased demand for municipal services. As part of future planning, integrated development planning with high residential densities would thus be critical for a municipality's shift to RE technology and services and especially for solar PV technologies.

In addition to innovation with regard to the INEP grant, the SPM needs to have an energy plan/policy approved by Council and with a clear goal on facilitating indigent household transition into the RE space. Moreover, through its state-owned CEF, the DoE-RSA has already demonstrated successful partnerships with the Ekurhuleni and Nelson Mandela Bay Metropolitan municipalities on the SWH installation pilot projects. The SPM could approach CEF for funding as part of its innovative funding model that could allow the indigent households and the municipality to benefit from RE. In one of the interview responses, manager D's assertion was that mobile solar systems would not be viable for indigent households connected to the grid "unless DoE could pay for installations". Through the proposed energy plan/policy, the SPM could direct that all new low-income housing settlements must be developed with specific renewable energy installations. In addition, DoE RSA also funds a conversion of lights to LED energy which could form part of the innovative funding model. Thus, the DoE-RSA emerges as a key player even under its existing grants and programmes which primarily include INEP, a grant on conversion to LED lights, CDMs as well as through the state-owned entity, CEF, whose mandate includes the promotion of RE (CEF, 2014/2015). All these grants combined should be considered for medium- to long-term initiatives for transitioning to RE for municipalities and for indigent households in particular.

Through the Green Fund which is managed by the DBSA, the Department of Environmental Affairs (DEA) provides funding for climate-change-related initiatives such as transitioning from fossil fuels to RE generated electricity. One of the sub-programmes within the Green Fund is Green Cities and Towns, whose specific focus is RE, including off-grid and mini-grid electricity infrastructure, with eligible applicants being municipalities and Small, Medium and Micro Enterprises (SMMEs). Funding is available in various forms, such as loans, equity and grants which are recoverable or non-recoverable. As examples of successful beneficiaries of the Green Fund, the City of Cape Town received a R50 million grant in 2015 to retrofit low-cost housing over a three-year period, and in the same year the Stellenbosch Municipality received a R17 million grant in recognition of the innovative iShack project for solar energy provision to un-electrified informal dwellers (Nieuwoudt, 2015). The SPM could consider applications for loans from the DBSA and considering that the DBSA already manages the Green Fund on behalf of the DEA-RSA, the SPM could also apply for loans or grants under the Green Fund.

The DEA-RSA is therefore a critical partner in achieving an innovative funding and business model that could benefit both indigent households and their respective municipalities. Such loans could complement the already guaranteed grant from the National Treasury, and especially the ESG for FBE. As emphasised by manager E, “the municipality must upgrade insufficient infrastructure that was implemented prior to 1994”. That on its own could be a rationale for loan application to the DBSA and an opportunity to install infrastructure that would also give impetus to future RE energy needs of the city and especially for the current vulnerable indigent households.

Secondary data analyses were conducted on other funding sources such as International Council for Local Environment Initiatives (ICLEI), which focuses on low carbon initiatives in cities. The SPM is a member of ICLEI and this already presents an opportunity to explore further partnering with them for participation of the indigent households in RE. ICLEI also aims at enhancing the transition to low emission urban development in emerging economies through facilitating selected local governments in Brazil, India, Indonesia and South Africa (UN-Habitat, 2015). In South Africa, ICLEI is involved in a variety of activities, including an initiative called Urban Low

Emission Development Strategies (Urban LEDS) which is aimed at promoting low carbon emission urban development strategies in model and satellite cities in South Africa, Brazil, India and Indonesia (UN-Habitat, 2015). Urban LEDS is funded by the European Commission and implemented by UN-Habitat and ICLEI. Its key mandate is capacity building for local governments.

Over the last few years, seven fast-growing municipalities in South Africa have teamed up with ICLEI to explore ways to enhance transition to a low emissions urban development model. These include Steve Tshwete (Mpumalanga), KwaDukuza (KwaZulu-Natal), Nelson Mandela Bay (Eastern Cape), Mogale City (Gauteng), as well as Umhlathuze (KwaZulu-Natal) (UN-Habitat, 2015). A Green Climate Cities methodology was piloted in these municipalities, whereby low carbon strategies were integrated into all sectors of urban planning and development within their Integrated Development Plans (IDPs). Strategy development and action plans, training and capacity building, as well as community showcase projects, are some of the initiatives under the Green Climate Cities model that were implemented in the aforementioned municipalities. The types of projects that were implemented include installation of a PV array at a community centre, retrofitting of solar water heaters, installation of mobile solar lights for twenty frail care homes, as well as information sharing on RE as a focus for an educational programme of the Umhlathuze/Empangeni Library.

Another funding mechanism identified through secondary data that could allow both indigent households and the municipality to benefit from RE is green bonds, such as those issued by the City of Johannesburg, where proceeds are used to finance a city's green initiatives (Naidu, 2015). The City of Johannesburg issued its first green bond of R1,46 billion on the Johannesburg Stock Exchange, an initiative that was supported by the DBSA which subscribed to about 29% (R502 million) of the total amount raised.

Secondary data on innovative funding mechanisms through Corporate Social Investment were also analysed (DoE-RSA, 2013). One example which would be applicable for the Northern Cape Province involves the successful REIPPP bidders being obliged to contribute towards socio-economic development of communities within a 50 km radius of the solar plant over a ten-year period. This is one of the

conditions to which successful bidders would have to comply. This could present an opportunity for successful companies to partner with municipalities within the set radius in order to advance RE, including the promotion of RE to indigent households. This would therefore constitute part of a proposed funding model to qualifying municipalities such as the SPM. Currently there is an operational solar plant within the SPM which falls under the national REIPPP and could therefore present such an opportunity.

In addition, further secondary data analysis highlighted that mining houses are required by law to implement Social Labour Plans (SLPs) in municipalities within which they operate as part of socio-economic plans that benefit communities (DMR-RSA, 2011). SLPs would entail agreements between a municipality and a mining house. Given the wide range of mining initiatives in the Northern Cape, this is yet another opportunity to ensure that SLPs under such project investment facilitate the municipality's transition to RE. Such complementary financial sources could allow both indigent households and the municipality to benefit from RE, particularly for municipalities close to REIPPP solar plants.

Philanthropic investment could be explored as an additional funding source. It is becoming increasingly common globally and in South Africa for the wealthy to donate funding for worthy causes. This needs more exploration as a potential fund for the envisaged business model. Examples could be to explore the Motsepe Foundation, Warren Buffet as well as the Bill and Melinda Gates Foundation, especially given that the Bill and Melinda Foundation was the primary source of funding for the iShack project.

The significance of PPPs for successful transitioning to RE should not be under-estimated. Local manufacturing of RE technologies is another innovative way that could allow RE to benefit both indigent households and the municipality. Partnering with the private sector in opening a solar manufacturing plant could prove beneficial in the long run as such a plant would not only be providing cheaper products as they are local but would contribute to job creation facilitated through developmental local government initiatives. Municipalities may develop incentives for investors on RE as a funding mechanism. Municipalities have full autonomy on the types of incentives they can extend to investors in order to promote their strategic agenda. The leasing

of RE technology systems from the private sector over an agreed period, and a repayment plan with the municipality as a partner, could enhance the potential of RE transitioning, especially through mitigating risks, with indigent households paying monthly affordable instalments to the supplier.

For capacity building and training, the following funding sources could be approached: the DEA-RSA, the German Society for International Cooperation (GIZ), ICLEI, the South African Renewable Energy Technology Centre (SARETEC) which aims at training within targeted RE initiatives. SARETEC is a partnership between government and the private sector. As part of government's SETA programme, the Energy Sector Education and Training Authority (ESETA) funds capacity building within the RE space. For medium- to long-term funding solutions for shifting to RE by municipalities, the following additional sources could be explored further: carbon finance, CDM and carbon credits. Under CDM, an emitter of GHG can invest in a project in a developing country thus gaining CER. Again, the role of the DoE as a CDM Designated National Authority becomes quite significant.

5.6 Innovative renewable energy business model

For a funding model to be effective, there should be a complementary business model. Secondary data analysed in this study indicates the key variables that must be taken into consideration for an effective business model: government should contribute seed funding, the private sector should implement, and users must be willing to pay, based on the 'pay for service model'. Supplementary sources of income could be used to augment existing subsidies. Such alternative income sources include personal individual savings and stokvels (a savings or investment society to which members regularly contribute an agreed amount and from which they receive a lump sum payment). Within a South African context, stokvels constitute a proven mechanism for resilience within a safe network of social support. Identification and removal of financial, administrative and logistical bottlenecks within the RE space is equally important.

A percentage contribution by beneficiary households towards the purchase of a new system would be critical in order to inculcate a culture of ownership, pride and fulfilment as the project/initiative grows and matures to satisfactory performance

levels. Awareness campaigns and training about RE are equally important for long-term sustainability of home systems. It is also important for municipalities to embark on pilot projects as a key initiative through prototypes and demonstration of the real benefits/merits of RE transitioning for all actors involved.

5.7 Conclusion

Through secondary data analysis, various funding streams which could be considered as part of RE model were discussed. An innovative funding and business model should be underpinned by integrated human settlements' development planning with high residential densities, coupled with responsive town planning processes. As a way to leverage future funding streams, the SPM can motivate accessing DoE-RSA and DEA-RSA grants upfront for utilisation on RE electricity connections using backcasting approach. This could allow both indigent households and the municipality to benefit from RE transition. Use of appropriate RE technologies needs to form a framework for RE transitioning.

Primary and secondary data analysed in this chapter gives an insight into funding options that could allow for RE-transitioning benefits for indigent households and the municipality. In addition, the success of the municipality's innovative funding and business model rests on changes to the prevailing SPM business model, especially with regard to electricity provision for indigent households. In the next chapter the study draws together findings from the previous chapters in order to consolidate the overall findings, conclusions and recommendations.

Chapter 6

Overall findings, conclusions and recommendations

6.1 Introduction

This chapter of the study addresses the primary research question which explores different funding and income streams towards an innovative business model to ensure that municipalities and indigent households benefit from the emerging RE.

Research question number 1: "*What are the key characteristics of the current funding and business model for electricity provision to indigent households for Sol Plaatje Municipality?"*

Research question number 2: "*What would be the innovative funding and business models which could allow both indigent households and the municipality to benefit from the transition to renewable energy technologies and services and thus mitigate on their prevailing vulnerabilities?"*

Key findings on research questions 1 and 2 (Chapters 4 and 5) are collated in this chapter and integrated into a response to the working hypothesis which is an appropriate combination of funding and business model combined with the right technologies and can allow indigent households to participate effectively in RE whilst benefiting from, as well as contributing to, energy and revenue generation. The theoretical and conceptual framework presented in Chapters 1 and 2 are also correlated to the research findings. Conclusions and recommendations are presented and research gaps are highlighted for future research on participation of indigent households in RE.

6.2 The Renewable Energy for Low-Income Earners Model

The findings and recommendations that have emerged from the study are brought together as the "Renewable Energy for Low Income Earners" (RELIE) model. Fundamental in this model is a systems approach rather than compartmentalisation of independent disciplines. As argued by Senge (2006), systems thinking is a

discipline of seeing wholes and not isolated parts. It is a framework for seeing interrelationships and for seeing patterns of change. The RELIE model is one such system of change that sees into the future. It is about interconnectedness, interdependence and sustainability. It therefore addresses the two fundamental aspects to seeing systems, i.e. seeing patterns of interdependency and seeing into the future (Senge, 2006). It is increasingly important for municipalities to carve a new alternative to energy provision for their citizens in general, and for indigent households in particular.

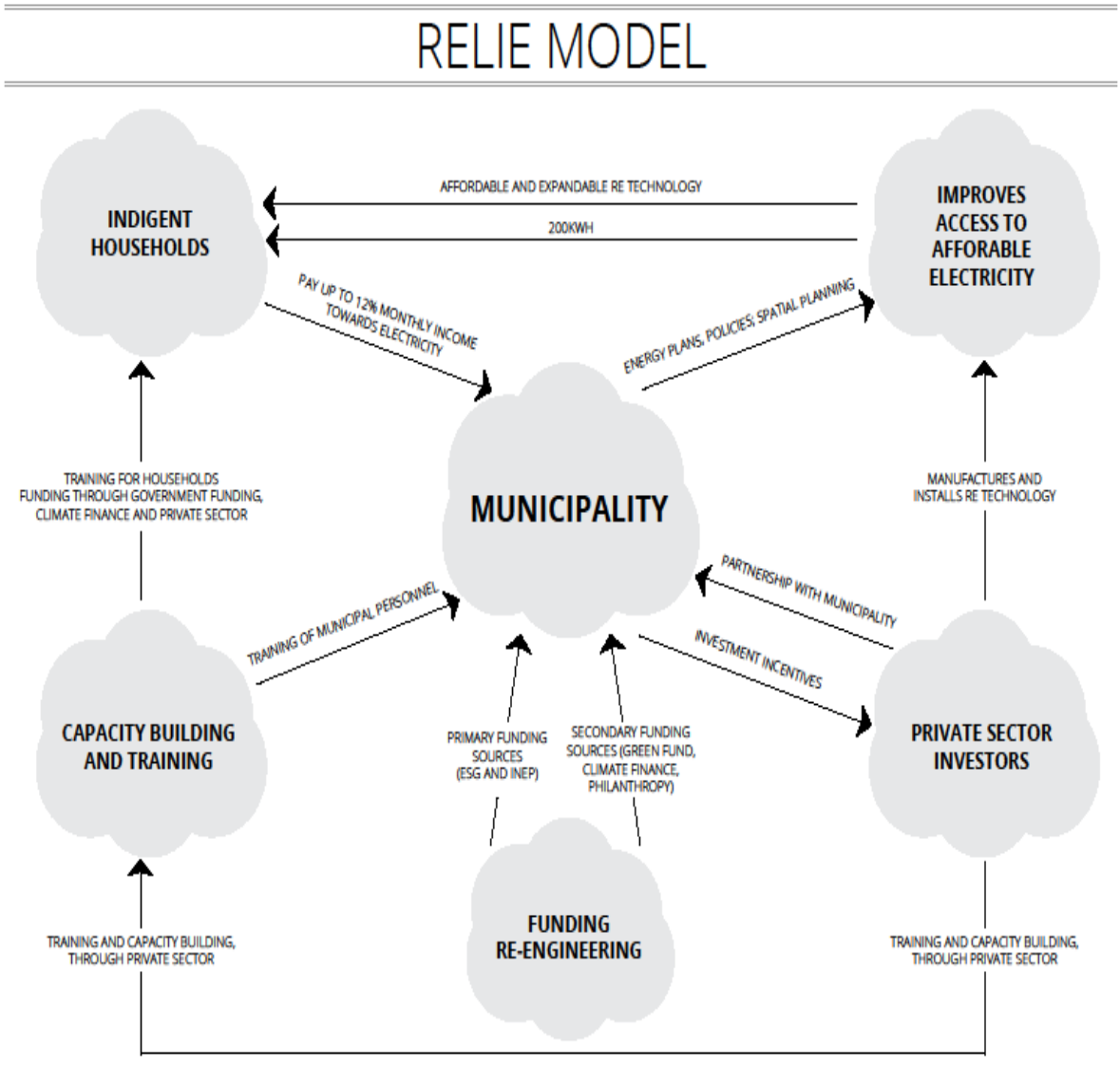

Figure 6.1: Schematic representation of Renewable Energy for Low Income Earners Model

The key elements of this innovative business and funding (RELIE model) are described below in Section 6.3 and in Figure 6.1 above, where each key component

of the RELIE model and related central themes are explored. Government, the end-user and the private sector are the key role players in the model with each playing a distinct but complementary role. Whereas the primary role of government is through policy regulations (FBE and investment incentives), the role of the private sector would be that of policy implementation coupled with affordable technology system innovations. Indigent households as end-users pay through accessing affordable electricity services with pay-for-service as the key element. Underpinning the RELIE model are thematic findings, which include sustainability, affordability, accessibility and benefit. For the model to be effective and successful in its implementation, these themes should be applicable to both the municipality and indigent households.

6.3 Key components of the Renewable Energy for Low-Income Earners Model

6.3.1 Free basic electricity re-engineering

In its current form, Free Basic Electricity needs complete re-engineering premised on access, benefit and affordability. Based on analysis of data it is recommended that government and municipal funding be utilised as a base and catalyst for provision of electricity from RE, in which indigent households are included. In this study it was argued that for an effective shift to RE, the municipality could use backcasting of the future FBE guaranteed budget allocation to the present, and utilise such a fund as a financial base for shifting to RE. Equitable Share Grant through FBE subsidy, INEP grant, and SPM's own funding which normally contributes to top up the INEP grant, constitute the first and primary funding layer of the RELIE model that could allow the municipality and indigent households to participate in RE, particularly solar. For an innovative business and funding model for shifting to RE while benefitting both indigent households as well as the municipality, the SPM needs to submit a motivation to the DoE-RSA to utilise the INEP grant for future electricity infrastructure connections for solar energy. Given that the mandate of the DoE-RSA is inclusive of promotion of RE, one would anticipate their consent. It was mentioned earlier that the SPM provides top-up funding on the INEP grant as it provides a higher level of electricity of 60 Amp instead of the national norm of 40 Amp. INEP, as well as top-up funding that the SPM always guarantees, could be used for all future RE

connections. The municipality would then be able to facilitate a shift to RE at the same level of resources/funding as deployed under its conventional model.

The grant from the DEA-RSA through the Green Fund and other DoE funds, such as the one towards replacement of lights with LED lights, all constitute a secondary layer in this scenario. Private sector investment and partnerships could also be secondary in this scenario. A basket of other funding instruments analysed in Chapter 5 could be more effective if they are included as complementary to the primary and/or secondary funding as highlighted above. Also, proposals need to be linked to the Spatial Development Framework which spatially represents the city's future growth and thus guiding public and private-sector investments in the city. For example, where future integrated human settlement developments are planned, the municipality could backcast its FBE budget and upfront apply for funds and subsidies from the DoE-RSA and DEA-RSA. Such an initiative does not only improve service delivery, but it improves the municipality's governance and strengthens intergovernmental relations that are crucial for the envisaged transformational development.

6.3.2 Improved access to affordable electricity

As argued in Chapter 4, on average, indigent households spend 28% of their income on energy which constitutes a percentage that is over two times higher than the acceptable norm of 12% for a low-income household (Sugrue and Lebelo, 2009). Adam (2010), Makonese (2006) and Ruiters (2009) supported the above with their arguments on insufficiency of the monthly 50kWh which only caters for between 14% and 19% of a households' energy needs. The inadequate levels of affordability limit access to energy have been argued throughout the study. There is therefore a need to reduce energy cost burden and improve energy access to the indigent households that caters for at least 80% of their households' energy needs. On the other hand, indigent households have to pay a maximum of 12% of their monthly income towards electricity. Thus, the municipality needs to provide at least 200kWh of energy, while indigent households pay a monthly average of R180 towards energy, based on average monthly income of R1 500.

6.3.3 Investment incentives

In this proposal, the municipality's role would be to create opportunities for entrepreneurship and incentivise the private sector which invests in manufacturing RE solar home systems and/or PV plants with the municipality as a partner. This could increase the municipality's appetite in pursuing a shift to RE, in partnership with the private sector. Installers could be part of manufacturing value-chain and that could be regarded as a stronger incentive to invest in the solar plant. The more RE units are installed, the higher would be the profits from the RE industry. Another advantage is application of a decentralisation and local model whereby mobile home systems/units are locally manufactured and are thus likely to be comparatively cheaper than imported ones. Localisation would also boost job creation which would be an additional benefit for the city through sustainable jobs.

6.3.4 Renewable energy infrastructure installation

The choice of installing RE infrastructure would depend on whether home systems are to be installed in an existing home or on a new development. With associated costs that have already gone into installation of current electricity infrastructure on current indigent households, it would be rational to prioritise RE grid-tied systems that would be integrated with the infrastructure already in place. As concluded from the primary and secondary data analysis, input costs will be high and fixed (at approximately R25.2 million), namely operations, maintenance and personnel costs, hence the need to maximise the benefit of RE on existing infrastructure, as argued in Chapter 5. Primary data analysis further confirmed that the only cost to the municipality for shifting to RE would be the cost for replacement of existing non-conforming meters. If new low-income human settlements are provided with RE systems with appropriated meters, the municipality could proactively be shifting to the RE model. Given insights from secondary data of iShack SPM could adopt technologies that use DC as opposed to AC form of electricity as the former apparently uses less power. The findings also motivate for allowing for upgradable systems based on the changing levels in household affordability.

6.3.5 Utilisation of affordable mobile technology

Home solar systems such as those shown in Figures 6.2 to 6.4 could be adopted as start-up RE technologies for indigent households. The municipality could apply an incremental approach using these technologies as a base to shift to RE. In its energy plans and policies, the SPM needs to consider the adoption of a FiT model linked with smart metering where consumers can become producers of electricity by feeding surplus electricity back to the grid and being reimbursed for it. The first step after approval of a FiT policy would be the conversion of meters to becoming smart meters that are equipped to differentiate between energy drawn from the grid by consumers and surplus energy fed onto the grid. Should the municipality adopt such a policy, it would mean indigent households would not only benefit in terms of access to energy for daily consumption but also financially as prosumers should they generate surplus energy to the grid. This would be one way for the city's transitioning from fossil fuels to RE. Gujba et al. (2012: 75) noted that one of the success factors for RE implementation would be responsive policies such as FiT whereby power generated through FiT households receives guaranteed payments at a guaranteed tariff. In addition, use of multi-purpose RE technologies is important to consider when shifting to RE. As argued in Chapter 2 and Chapter 5, RE technologies chosen need to take into cognisance the local climatic conditions.

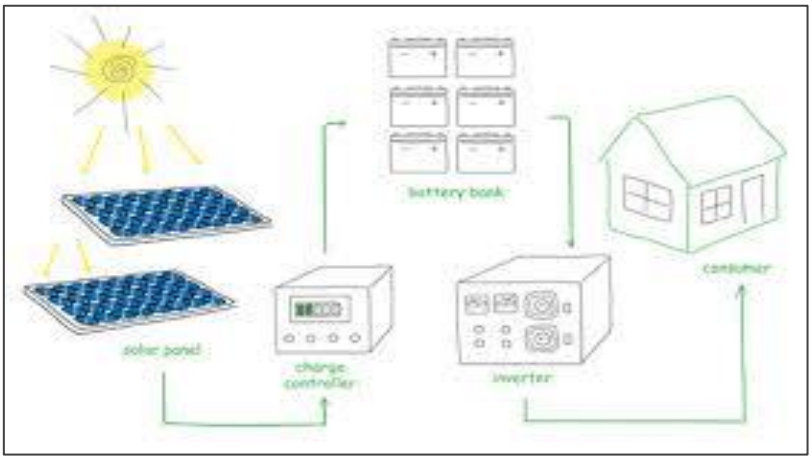

Figure 6.2: Homemade solar power (Source: Samlex Solar, 2016)

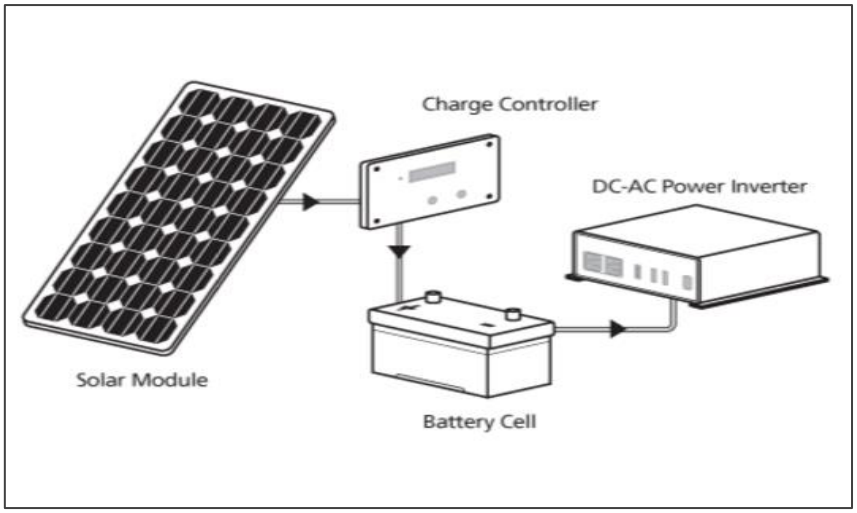

Figure 6.3: Non-grid-tied solar power system (Source: Samlex Solar, 2016)

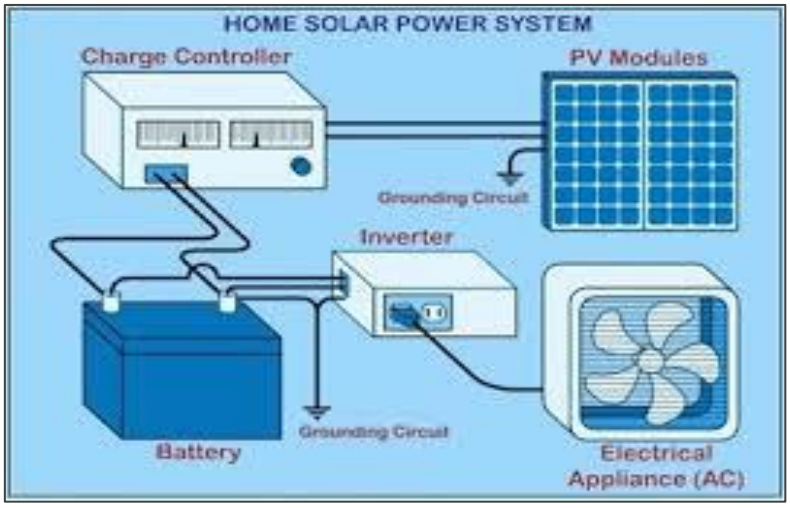

Figure 6.4: Home solar power system (Source: Samlex Solar, 2016)

6.3.6 Private sector driven one-stop-shop

A private sector driven one-stop-shop-model is envisaged in order to provide microfinance, supply RE technologies and provide aftersales training to indigent households. This can be run through a PPP initiative. Indirectly, this could be a major contributor to local economic development through entrepreneurship where members of the community could participate, for instance through NGOs who could be financiers and trainers. This model opens up entrepreneurial opportunities while

minimising risks to the municipality thus leaving room for the municipality to play the role of a guarantor for the indigent households.

6.4 How the RELIE model addresses central themes

Table 6.1 provides an overview on how the RELIE model addresses the central themes prioritised in this study, which are sustainability, affordability, accessibility and benefit. These are applicable to both the municipality and the indigent households. Both the municipality and indigent households must be able to demonstrate improvements to their status quo conditions through value-adding should the proposed model be implemented.

TABLE 6.1: THEMATIC REPRESENTATION OF RENEWABLE ENERGY FOR LOW INCOME EARNERS MODEL

Theme	Status quo	RELIE Model
Sustainability	**Municipality** The municipality is challenged by an increasing risk of high demand for municipal services due to urbanisation. Inherent risk facing the municipality of a dwindling electricity revenue base from middle- to high-income earners who opt for RE. The latter currently play a significant role in cross-subsidisation for the indigent households, however, should they decide to shift to RE, the financial base on which the municipality relies on for cross-subsidisation would be reduced, thus leading to perpetual risk on the municipality to single-handedly provide energy to indigent households – high risk that could lead to a municipality becoming unable to afford rising costs for indigent household benefits.	**Municipality** One of the advantages of RELIE model to the municipality would be increased ability to provide affordable electricity to all its citizens. In addition, its application is seen as a mitigating factor on inherent risk of dwindling electricity revenue base from middle- to high-income earners who opt for RE. These are contributory factors to a municipality's sustainability.
	Households Indigent households are faced with suppressed demand, a concept which takes into account the fact that the per capita emissions of the indigent households are low. However, these would increase if the indigent households had better access to energy and appliances (Carbon Market Watch, 2015). Thus, better access to energy for indigent households will lead to higher per capita emissions.	**Households** Nissing and Von Blottnitz (2009:2184) argued that "increased energy consumption is positively correlated to increased quality of life". Middle-income lifestyles are inevitable as people tend to strive for more once their affordability levels improve. Reduced suppressed demand results in improved socio-economic conditions.

Theme	Status quo	RELIE Model
	Also, there is risk of tampering with the system, electricity theft, overloading of the system, etc.	
Affordability	**Municipality** High costs of provision of electricity to indigent households.	**Municipality** Through shifting to RE, the risk of perpetual rising operating costs are reduced. As argued earlier in the research, many RE projects have low levels of operating costs (Gujba et al., 2012: 75) and as such pose an advantage to the municipality with regard to costs.
	Households Indigent households are excluded from the benefit derived from access to energy/electricity as is currently the case with the SPM model of electricity provision. As a result, indigent households bear the risk of a high-energy burden which is on average 28% of their income per month, compared with an average norm of 12% (Sugrue and Lebelo, 2009).	**Households** Affordability by households improved with expenditure towards energy/electricity being brought within the acceptable norm of 12%. General socio-economic status will improve as reduced expenditure results in savings towards other household needs.
Access	**Municipality** Currently a few indigent households access FBE. Due to a limited communication strategy by the municipality to indigent households encouraging those	**Municipality** Under the RELIE model there is a conscious effort by the municipality to shift to RE through various interventions, including targeted access to grants and funding opportunities from government for seed funding.

Theme	Status quo	RELIE Model
	who qualify to access FBE timeously, and also encouraging unregistered residents to do so, intended FBE beneficiaries do not access FBE optimally as they should.	Interventions include, but are not limited to, energy policy, integrated human settlements planning, town planning processes, applications to the DoE-RSA and DEA-RSA. The higher the number of registered indigent households, the better the chances of the municipality accessing a higher budget allocation of Equitable Share Grant for FBE.
	Households Access to FBE is limited to 15 days as beyond these days without submission of a claim of 50kWh, qualifying households forfeit the benefit. It was highlighted in the research as part of the primary data analysis that an FBE household beneficiary has an obligation to claim its FBE before the 15th of each month, and failure to claim would result in forfeiture of benefit. Four of the five households interviewed confirmed that they do not access FBE. Therefore, it was concluded that access to FBE by indigent households is limited, and so is the benefit linked to available and affordable electricity as they are required to also pay for units to which they are entitled.	**Households** Guaranteed improved access to energy/electricity as FBE has been included on input costs for RE for indigent households.
Benefit	**Municipality**	**Municipality**

Theme	Status quo	RELIE Model
	In the main there is marginal income derived by the municipality under the FBE umbrella. Income, although limited, is derived from indigent households through payment for rent/rates and other municipal services, including electricity, as they use prepaid meter systems which requires top-up perpetually.	Economic benefits include, but are not limited to, local production of solar home systems including job creation and reduction of GHG emissions. Also, adoption of the RELIE model brings certainty and predictability of municipal cashflow as the outflow budget towards purchasing of bulk electricity and unpredictable revenue from electricity sales would be reduced. The RELIE model brings predictability and stability. Another benefit would be good service delivery to its citizens, both middle- to high-income and indigent households can access affordable, clean and sufficient energy.
	Households FBE insufficient.	**Households** Better access to electricity at a more affordable cost, residential-based entrepreneurial opportunities, and generally improved quality of life.

Source: Researcher's own based on findings and conclusions

6.5 Implementation framework for RELIE model

As elaborated in Section 6.3, the proposed RELIE model comprises six main pillars, which are the re-engineering of free basic electricity programme, improved access to energy, investment incentives, RE infrastructure installation capital-cost, utilisation of affordable mobile technology as well as establishment of a private sector driven one-stop-shop. The RELIE model adopts a systems approach by considering the connections and interrelationships between different components as well as the connections between technical aspects of electricity provision, financial aspects, and broader imperatives such as addressing climate change. The effectiveness of the RELIE model lies in recognition of the whole and not individual parts. Its 'wholeness' would result in inclusion of indigent households in RE. As argued by Senge (2006: 352) "the innovations that will have the most significant impact will be the ones that integrate value chains for long term viability". The RELIE model resonates with this assertion. The need for forward planning, strategic thinking and integration with urban planning processes is also emphasised. The RELIE model is considered a feasible funding and business model that would promote participation of indigent households in RE whilst benefitting the SPM.

In order for the RELIE model and the aforementioned proposals to be effective, it would be critical to have an implementation framework for the recommendations and proposals. Critical in the implementation of RE, particularly for indigent households, are the following: good leadership; well-researched energy plans; consistent policies and programmes; public funded subsidies; government funding as financial base; climate finance, fiscal plans as well as a secure investment framework; use of appropriate, expandable and affordable technologies; ongoing awareness and training of affected municipal staff on RE and associated operations; systems maintenance; private sector partners for installation of RE systems; provision of space (land or building) by a municipality for utilisation by the private sector for their plant; and warehousing. Inherent in a successful implementation framework are government policy levers and finance. In the absence of any of these factors, sustainability of RE initiatives for inclusion of indigent households is likely to be low.

Phasing-in of the implementation of RE for indigent households would be another important factor to be considered by municipalities.

6.6 Conclusions and recommendations

As mentioned in Chapter 1, on one hand municipalities are faced with increasing demand for services which they are required to fund through their own revenue streams, while on the other hand, there is high and still escalating dependency by indigent households on municipalities for provision of basic services including electricity. Other challenges that emerged in this study include vulnerability of indigent households to energy poverty and the high energy cost burden. Given that the aim of this study was to explore and substantiate the possibility of a responsive innovative municipal funding and business model that could allow indigent households and the SPM to benefit from RE, the findings and recommendations of the study have provided deeper insight. These were consolidated into the proposed RELIE model. The hypothesis that the indigent households can access and participate effectively in RE space while contributing to energy and revenue generation, could be realised through the RELIE model even though this remains at conceptual level as it was not possible to test it even as a prototype.

In addressing the research questions, the RELIE model is a comprehensive, innovative funding and business model that the SPM could implement to promote the participation of indigent households in RE, particularly solar, while deriving benefit for the municipality as well. As discussed in Sections 4.3 and 4.4, in its current form the status quo SPM model of service delivery to the indigent households is expensive and unsustainable. As conceptualised from the findings of the study, the RELIE model is regarded as affordable and sustainable, thus resulting in benefits for both the indigent households as well as the SPM. The model is also envisaged to be an effective and sustainable way to mitigate exclusionary greening of South African cities, based on the findings of the Galeshewe case study. This study is viewed as ‘breaking new ground’ in terms of municipal energy provision models. A detailed comparison of the current model and RELIE model is presented in Table 6.1.

Although the findings of the study are tied to SPM as a case study, the proposed RELIE model could be adapted for responsive implementation in other municipalities

in South Africa. It should be designed in a manner that can leverage private finance for sustainable development of the city in the long term. As proposed, a successful business and funding model that comprises public, private and end-user interaction is critical. For the RELIE model to succeed, it would require sustained political will, policy coherence, clear regulatory frameworks, as well as a secure investment framework (Breytenbach, 2015: 2). The same success factors need to be carried through for the successful participation of indigent households in RE through the proposed model.

As highlighted in Chapter 1, this research is transdisciplinary as it transcends various disciplines, i.e. engineering, finance, and ICT amongst others. Emerging from the study is a new paradigm that SPM can adopt and implement. In addition, as this is an emerging field it is faced with the reality of limited knowledge particularly as far as it relates to research on municipal business and funding models that could be promoted for participation of indigent households in RE. The study is about an alternative discipline, which is at developmental stages with limited literature. Recommendations of this study could be used by practitioners from different disciplines such as engineering, town planning, finance and ICT. As discussed in this study, findings of this research could be implemented in other municipalities in South Africa. Municipalities which adopt this model could improve livelihoods of indigent households while reducing greenhouse gas emissions that contribute to climate change, as well as improving their revenue base.

The final section of the study captures the identified research gaps that could be explored in future. These include implementation of RELIE model including pilot testing and prototyping of the model, systemic implications for ESKOM and municipalities of feeding power to the grid, and research on the RE institutional model that encompasses long-term sustainability of RE initiatives and leadership, while the municipal revenue base is enhanced. The entire fossil-fuels based value chain linked to electricity generation, procurement framework, jobs, coal industry in general, would be negatively affected through shifting to RE. Political, socio-economic implications and general governance relating to the proposed RELIE model could equally form part of further studies. An institutional model could also focus on the capacity and capabilities of municipalities to comprehend, implement

and sustain the RELIE model, with consideration of available personnel who could implement the RELIE model, as well as related skills gaps in municipalities.

The summary of recommendations for mitigating exclusionary greening of South African municipalities through participation of indigent households in RE are further summarised below:

Adoption of an innovative funding and business model, the RELIE model, which comprises the following:

a. Free basic electricity re-engineering;
b. Funding re-engineering to encompass primary and secondary funding sources;
c. Improved access to affordable electricity;
d. Promotion of investment incentives to attract private sector;
e. RE appropriate infrastructure installation;
f. Affordable and expandable technology for indigent households;
g. Capacity building and training for both indigent households and the municipality;
h. Promotion of Public Private Partnership with the private sector as an investor and an implementer.

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Appendix A
Ethics Clearance Certificate

SCHOOL OF ARCHITECTURE AND PLANNING
HUMAN RESERCH ETHICS COMMITTEE

SCHOOL OF ARCHITECTURE PLANNING

CLEARANCE CERTIFICATE
PROTOCOL NUMBER: SOAP130/28/03/2017

PROJECT TITLE:	Exclusionary greening of South African cities: Participation of the poor in renewable energy with particular reference to solar.
INVESTIGATOR/S:	Nomonde Tyabashe-Keslamang (Student No. 694094)
SCHOOL:	Architecture and Planning
DEGREE PROGRAMME:	MArch(SEEC)
DATE CONSIDERED:	28 March 2017 – RE-ISSUE
DECISION OF THE COMMITTEE:	APPROVED
EXPIRY DATE:	28 March 2017

CHAIRPERSON
(Professor Daniel Irurah)

DATE: 28-03-2017

cc: Supervisor/s:

DECLARATION OF INVESTIGATORS
I/We fully understand the conditions under which I am/we are authorized to carry out the abovementioned research and I/we guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I/we undertake to resubmit the protocol to the Committee.

Signature

28/03/17
Date

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Appendix B
Household Interview Guide Questions

HOUSEHOLD QUESTIONNAIRE

SECTION 1

Area:
Time:
Day:
Data Collector:

SECTION 2: DEMOGRAPHIC INFORMATION

Gender

MALE	
FEMALE	

Age

18-21	
22-30	
31-40	
41-50	
51-60	
Above 60	

Education

No schooling	
Primary school level	
Secondary School level	
Matric level	
Higher Education (certificate, technical school qualification)	
Higher education (diploma, degree)	
Higher education (honours & masters)	

Employment

Employed Full Time	
Employed part-time	
Unemployed	
Other (specify)	

Household Income per month

R0-R1000.00	
R1000.00-R2000.00	
R2000.00-R3500.00	

SECTION 2

ENERGY POVERTY

1. For how long have you been staying here?

0-5 years	
5-10 years	
Over 10 years	

2. How many people are staying in the house?

3. What type of municipal services do you receive?

Electricity	
Water	
Refuse Removal	

4. Which ones do you pay for monthly?

Electricity	
Water	
Refuse Removal	

5. Which ones of the following services are you getting from the municipality at no cost?

Electricity	
Water	
Refuse Removal	

6. How much do you spend on electricity per month?

7. Does electricity you buy cover for all your needs?

8. Do you use any of the following forms of energy for cooking, lighting, etc.?

Paraffin	
Kerosene Gas	
Wood	
Candles	
Other	

9. How often do you use them in a month?

1 Week	
2 Weeks	
3 Weeks	
4 Weeks	
Other	

10. Do you have all the appliances you would like for a household of your size?

11. What other appliances would you buy had you been given such an opportunity?

12. Are you happy with the amount you spend on electricity and other forms of energy already mentioned?

13. How much would you be happy to spend on electricity monthly?

14. I notice that you are currently using a solar water heater (geyser), has it improved your quality of life? How?

15. Has your electricity bill decreased since the SWH was installed?

YES	
NO	

16. By how much per month?

R100 – R200	
R300 - R500	
R600 - R1000	
Other	

17. Would you consider converting into solar electricity in the future given such an alternative?

YES	
NO	

18. Why?

Appendix C
Municipal Personnel Interview Guide Questions

SECTION 3:

ESG and FBE

FINANCE DEPARTMENT

1. Briefly explain Equitable Share Grant and Free Basic Electricity

2. What is an annual budget for provision of FBE to indigent households?

3. How much is each household entitled for FBE?

4. Do you think 50kWh is enough for household electricity consumption?

YES	
NO	

5. How many indigent households there are in the city?

6. How many have been provided with FBE?

7. Does the municipality benefit from FBAE?

YES	
NO	

8. Which areas qualify for FBAE?

9. How much does the municipality spend monthly to purchase electricity from Eskom? And what is % of municipal monthly budget?

10. How much % is revenue received from electricity sales monthly?

11. Has it increased or decreased since the last three financial years? (If decreased, answer 12; if increased answer 13)

12. What do you think causes it to decrease?

Lack of affordability	
Culture of non-payment	
Electricity Theft	
Over-Billing	
People are using solar	
Other	

13. What do you think causes it to increase?

Increased income levels		
In-migration		
New housing developments		
Change of Attitude		
Incentives received for paying electricity		
Other		

14. I am aware that annually the municipality makes provision for bad debt. How does it work?

15. Who tend to have their accounts cancelled under 'Provision for bad Debt'?

16. For the past three financial years, has provision for bad debt amount increased or decreased?

17. What is your comment with regards to the current scenario of electricity sales and bad debts?

18. Do you think that the municipality continues with the status quo with regards to electricity provision, bad debts, etc. or consider an innovative way to provision of electricity to its indigents? Why?

19. Would you consider RE (solar) as viable option for the municipality to adopt as an alternative energy source for its residents? Why?

BASIC ELECTRICITY PROVISION

ELECTRICITY DEPARTMENT

1. What is the City's current electricity demand?

2. How would you rate provision of electricity to low income households / indigents by the municipality?

Low	
Medium	
High	
Other	

3. What are total infrastructure costs to providing each household with electricity?

4. What are sources of funding for provision of electricity to the City?

5. How do you access funding sources?

6. Is funding always approved by funders? Is it always guaranteed?

YES	
NO	

7. What is your comment with regards to FBE?

8. What role does Electricity Department play in solar photovoltaic systems that are installed by individual households in the City?

9. Mention risks that are associated with electricity consumption in low income areas in particular?

10. What strategies can be employed to mitigate such risk/s?

11. Are there RE strategies/policies and planned programmes the municipality is involved in?

MIGRATION PATTERNS

URBAN PLANNING DEPARTMENT

1. What is your view with regards to the growth of the City?

2. What drives such growth? (Is it in search for opportunities or education in the light of Sol Plaatje University)

Natural causes (Birth)	
Economic opportunities	
Educational opportunities	
Other	

3. What are migration patterns within the municipality?

4. Which segment of the population drives this growth?

Educational	
Economically Active	
Other	