

Broadening the discourse on small-scale generation: an investigation into public opinion of embedded rooftop photovoltaic systems in Stellenbosch

By:

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Declaration

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Abstract

This paper investigates and critically evaluates the effects of the emergent approach taken towards the uptake of distributed generation (DG) systems in South Africa. The study focuses on a case study conducted in Stellenbosch, Western Cape, on the uptake of small-scale embedded generation photovoltaic (SSEG PV) systems, and compares this with a literature review of strengths and weaknesses of the approaches towards the promotion DG that have emerged elsewhere in the world. The study includes a focus group conducted with ten participants (homeowners from Stellenbosch) to determine their opinions of the feed in tariff (FiT) scheme enabled by Stellenbosch municipality in the absence of national policy guidance. This scheme will ultimately allow them to connect their rooftop PV systems to the municipal network and sell excess electricity to the municipality. The findings of the case study and literature review are triangulated with theory on sustainable development, systems thinking and complexity in order to assess the extent to which the emergent South African approach is aligned with goals for sustainable development expressed in national development policy and by the United Nations Environment Programme.

The results of the case study reveal that participants' responses to the FiT scheme are more complex than originally thought, and can provide some insight into why the FiT scheme has been less successful in encouraging homeowners to invest in SSEG PV systems than expected; while the results of the literature review reveal that more holistic approaches to the promotion of DG systems are generally more successful than those that rely on the provision of limited financial incentives. Ultimately, the research shows that South Africa could benefit from a more holistic approach towards the design of strategies for the uptake of SSEG PV systems, and DG in general, if the country is truly dedicated to achieving goals for sustainable development. This study also and provides suggestions of what such an approach could look like.

It is recommend that the Stellenbosch Municipality reconsider their R140 fixed monthly grid connection fee, if they are committed to discussions regarding the sustainable uptake of distributed generation (DG) or small-scale embedded generation (SSEG). A longer-term perspective is also required to consider how the benefits of increasing the uptake of these systems can be monitored and realised in real terms. Finally, it is recommend that future researchers continue to broaden the input from electricity consumers (and potential prosumers) and take on the task of generating knowledge on consumer need and opinion regarding the increased uptake of RE and SSEG, and of increasing the scope of such research to various race, gender and socio-economic groups to improve the promotion of equality in energy and electricity developments in Stellenbosch.

Opsomming

Hierdie studie ondersoek en evalueer die uitwerking van die opkomende benadering tot die inkoop van verdelende generasiesisteme (*DG*) in Suid-Afrika. Deur 'n gevallestudie onderneem in Stellenbosch, Wes- Kaap, word die aanvaarding van 'n kleinskaalse opkomende generasie *PV* (*SSEG PV*) sisteem beproef. Dit word vergelyk met 'n literatuurstudie wat beide die sterkpunte en swakhede van die benadering evalueer om sodoende die opname vooruitgang wat elders in die wêreld ontstaan het, te bepaal. 'n Fokus groep van tien deelnemers (huiseienaars van Stellenbosch) se menings oor die terugleweringvergoedingskema (*FiT*) wat geïmplimenter word deur die Stellenbosch munisipaliteit in die afwesigheid van die nasionale beleidsriglyne is bepaal. Hierdie skema sal dit uiteindelik moontlik maak om *PV* stelsels vanaf huishoudelike dakke aan die munisipale netwerk te verbind en daardeur surplus elektrisiteit aan die munisipaliteit te verkoop. Die bevindinge van die gevallestudie en literatuurstudie is versoenbaar met die teorie wat onderliggend is aan volhoubare ontwikkeling, sisteemdenke en kompleksiteit. Dit bepaal hoe die ontluikende Suid-Afrikaanse benadering gekoppel is aan die doelwitte van volhoubare ontwikkeling wat beide in die nasionale ontwikkelingsbeleid en die Verenigde Nasies se Omgewingsprogram uiteengesit word.

Die resultate van die gevallestudie dui daarop dat die deelnemers se reaksies tot die *FiT* skema meer kompleks is as wat aanvanklik verwag was en kan insig gee tot hoekom die *FiT* skema minder suksesvol is om huiseienaars aan te moedig om in *SSEG PV* sisteme te belê. Die resultate van die literatuurstudie bevind dat die meer holistiese benadering tot die bevordering van *DG* sisteme, oor die algemeen, meer suksesvol is as dié wat staatmaak op die voorsiening van beperkte finansiële aansporings. Uiteindelik bewys die navorsing dat Suid-Afrika voordeel kan trek uit 'n meer holistiese benadering tot ontwerp van strategieë vir die aanvaarding van *SSEG PV* sisteme, en *DG* sisteme mits die land werklik verbind is tot die bereiking

van doelwitte vir volhoubare ontwikkeling. Hierdie studie bevat ook voorstelle vir die ontwerp van so 'n benadering.

Dit word aanbeveel dat die Stellenbosch Munisipaliteit die vasgestelde maandelikse konneksiefooi van R140 moet heroorweeg, indien hulle verbind is tot die volhoubare aanvaarding van *DG* of *SSEG PV*. 'n Langtermyn analise is ook benodig om te oorweeg hoe die toenemende inkoop in hierdie sisteme bevorder kan word. Laastens word daar voorgestel dat toekomstige navorsing moet voortbou op kennis ten opsigte van die verbruikersbehoefte en menings oor die toenemende aanvaarding van *RE* en *SSEG*. Verdere navorsing wat ras, geslag en sosio-ekonomiese groeperings insluit, kan gelykheid van energie- en elektrisiteitsvoorsiening in Stellenbosch bevorder.

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List of Acronyms and Abbreviations

CCHP	Combined Cooling, Heat and Power Systems
CCT	City Of Cape Town
CES	Centralised Energy System
CRSES	Centre for Renewable and Sustainable Energy Studies (CRSES)
CSP	Concentrated Solar Power
DES	Decentralised Energy System (referred to here as DG)
DG	Distributed Generation
DoE	Department of Energy
ERA	Electricity Regulations Act
ESCO	Energy Service Company
FiT	Feed in Tariff
GDP	Gross Domestic Product
GE	Green Empowerment (Peruvian NGO)
GHG	Greenhouse Gas
HD	Human Development
ICE	Institute of Electricity (Costa Rica)
IDP	Integrated Development Plan
IIC	Infrastructure Innovation Committee
IPAP	Industrial Policy Action Plan
IRP	Integrated Resource Plan
JNNSM	Jawaharlal Nehru National Solar Mission
LSM	Life Standard Measure
JRA	Jonkershoek Ratings Association
MEC	Mineral Energy Complex
NDP	National Development Plan
NERSA	National Energy Regulator of South Africa
NGO	Non-Government Organisation
PA	Practical Action (Peruvian NGO)

PGD	Postgraduate Diploma
PV	Photovoltaic
RE	Renewable Energy
REIPPPP	Renewable Energy Independent Power Producers Procurement Programme
SALGA	South African Local Government Association
SD	Sustainable Development
SDF	Spatial Development Framework
SHS	Solar Home System
SSEG	Small-Scale Embedded Generation
TOD	Transport Oriented Development
UNEP	United Nations Environment Programme
VAT	Value-Added Tax
WCED	World Commission on the Environment and Development

Definitions

1. Centralised generation

Centralised generation refers to an electricity generation system, such as South Africa's, where several large-scale electricity generation systems are constructed and connected to transmission systems and then distribution systems. The transmission systems transport the electricity at high voltages over long distances until they reach the relevant local distribution networks. The electricity runs through a transformer and the voltage is lowered before entering the distribution network, where it is lowered again before going into supply households. Centralised generation relies primarily on fossil fuel generators such as coal (in South Africa) or large-scale renewable energy generators such as nuclear generation systems or large-scale hydro generation systems (in Brazil) (Toledo et al 2010; Baker et al 2014). These types of large-scale generation systems are generally able to generate electricity more cheaply and in large, reliable quantities, however, they all have significant negative effects on the natural environment and often rely on finite resources such as coal, gas or water (Bouffard & Kirschen 2008). Centralised generation is therefore increasingly being considered unsustainable and much research is going into finding ways of meeting electricity and energy needs more efficiently.

2. Distributed generation (DG)

'Distributed generation' refers to the phenomenon where electricity generation systems (usually between 1 W and 300 MW in size) are connected directly to (or embedded within) the local distribution networks (rather than first being connected to the transmission network of a centralised generation system). These systems are therefore often installed on the consumer side of the distribution network and are smaller in size than the centralised electricity generation systems mentioned above

(NERSA 2015). El Khatam & Salama (2004) explain that DG refers to a number of smaller generation systems that are located in close proximity to the energy consumers and to the energy resources needed to generate the energy required. These systems can be designed to generate and distribute either electricity or energy in other forms such as heat, and their designs vary according to the needs they must meet. These systems are often designed to use renewable energy resources such as solar or wind resources but this is not necessarily the case. Some DG systems are designed to be a combination of renewable and highly efficient conventional energy systems in order to manage the intermittency issues presented by renewable energy resources (Bourffard & Kirschen 2008). DG systems gained popularity in the late '90s and early 2000s, and many countries began experimenting with different types of applications to meet different energy needs. The term "DG" is interchangeable with terms such as dispersed generation (commonly used in North America), embedded generation (or SSEG), which is more commonly used in South America and South Africa, and decentralised generation (more commonly used in Europe and Asia) (El-Khattam & Salama 2004).

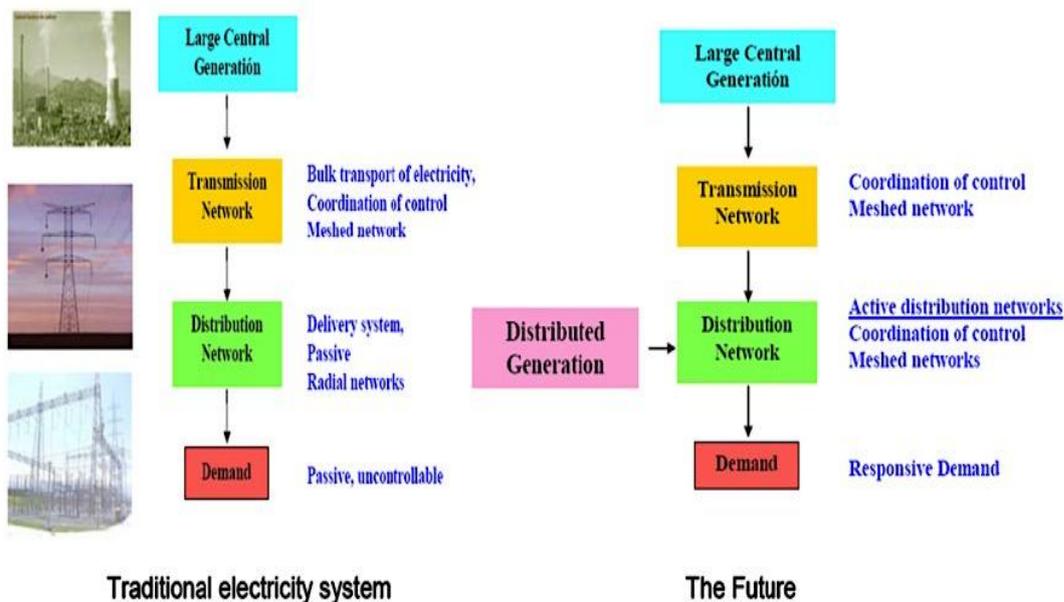


Figure 1: How DG systems can be integrated in future centralised generation systems (Source: Bayod-Rújula, 2009)

3. Small-scale embedded generation (SSEG)

This refers to very small-scale distributed generation systems that are connected to the local distribution network, of which the dominant technology in South Africa is small-scale solar PV systems (see definition below). Often the abbreviation SSEG is used to refer directly to small-scale embedded PV systems in South Africa (NERSA 2015). This is because this technology is currently more commercially viable than any other distributed generation system of this scale (1 kW and above, but below 1MW).

4. Solar resource

The term ‘solar resource’ refers to the amount of electromagnetic radiation and thermal energy that the earth receives from the sun. The solar radiation can be harnessed by solar energy systems to supply electricity to meet human needs and solar thermal energy can be harnessed to meet heat and cooling needs. Types of solar energy systems that capture solar radiation used to generate electricity include: Solar Photovoltaic (PV) systems and Concentrated Solar Power (CSP) systems. Types of solar technology systems to harness thermal energy include solar water heaters (Boyle et al 2012). On the map below, showing the solar radiation in South Africa, Stellenbosch is located roughly between Cape Town and Paarl.

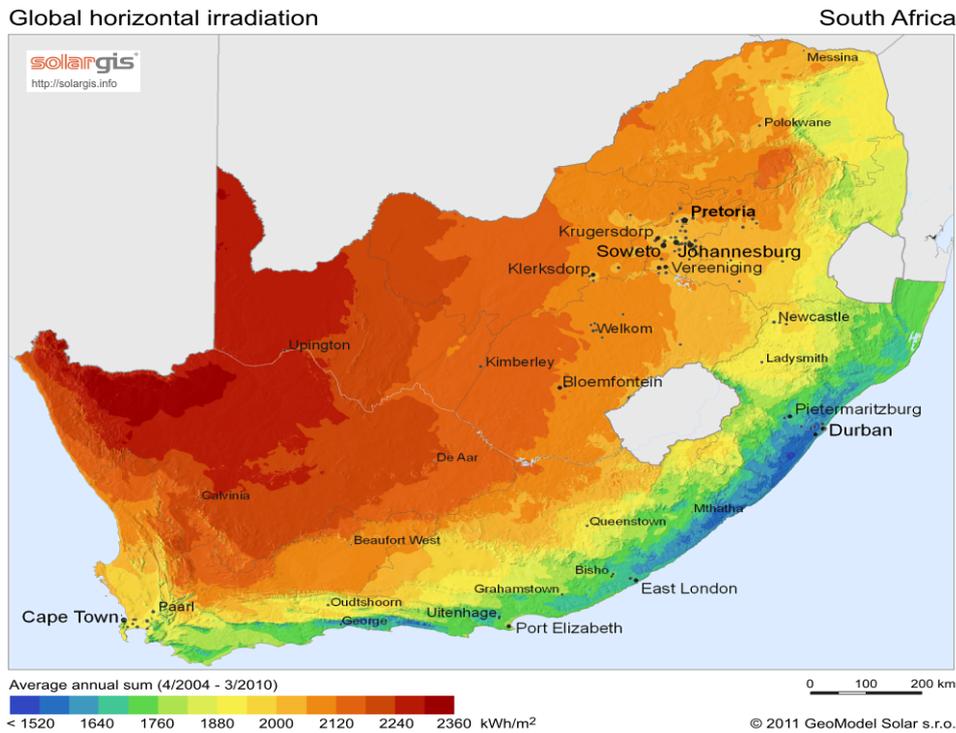


Figure 2: Solar radiation in South Africa and the related electricity generation potential (Source: GeoSun Africa 2016)

5. Solar photovoltaic (PV) technology

Solar photovoltaic, or just photovoltaic (PV), refers to solar energy systems that use solar radiation to generate electricity, and specifically to the technology that includes a panel of PV modules made of silicon (or crystalline silicon to enhance efficiency). A number of panels together is referred to as an array and the more panels one has, the more electricity one can generate. The panels are connected to an inverter to convert the DC to AC before the electricity is supplied to either the household's distribution system or to larger, transmission and distribution systems to be used elsewhere. These systems can vary in size quite significantly and can be used at household or at utility scale.

6. Rooftop PV and Embedded PV (or small-scale embedded PV)

Rooftop PV refers to small-scale solar PV systems, usually to supply electricity to a single household. The PV panels are generally placed on the roof of the household to increase exposure to the sun's rays. Embedded PV (or embedded rooftop PV or small-scale embedded PV) refers to small-scale PV systems, usually installed in people's homes to meet household electricity demand but that are also connected to the local distribution network, enabling the system owner to feed excess electricity back to the distribution authority, usually a municipality.

7. Electricity Tariffs

A tariff charged by the electricity provider (municipality or Eskom). Tariffs in South Africa are typically made up of an active energy charge (per kWh), a capacity charge (per kVA), and a set daily or monthly charge. All electricity tariffs in South Africa are approved by NERSA.

In the case of a SSEG tariff, an additional **grid connection fee** is sometimes added to the electricity tariff. This refers to an amount paid by SSEG (in this case the homeowner with the rooftop solar PV system) to the municipality (or owner of the local electricity distribution grid) for the right to connect the PV system to the local grid and feed excess electricity generated back to the distribution grid in exchange for a feed in tariff.

A **Feed in Tariff** is the tariff paid to the SSEG system by the owner of the local distribution network in exchange for electricity. In this case it is the amount that the local municipality will pay to the homeowner in exchange for the excess electricity generated by their rooftop PV system that is fed back into the local network for use elsewhere.

8. Grid Parity

Grid parity refers to the phenomenon where the cost of PV supplied electricity is comparable with the current cost of grid-supplied electricity (usually generated from conventional energy resources) (Boyle 2012).

9. Green Economy

Developing a Green Economy is one of the strategies in which the South African government is planning to implement a shift towards sustainable development. Montmasson-Clair (2012: 5) defines a green economy as an economy where “... growth in income and employment are driven by public and private investments that reduce carbon emissions and pollution, enhance energy and resource efficiency, and prevent the loss of biodiversity and ecosystems services.” The idea is therefore to take an approach to economic growth that attempts to design development that aims to integrate goals of sustainable development such as poverty alleviation, environmental protection and rehabilitation, and efficient resource management. This is instead of making unjust trade-offs between these goals, for example, job creation and environmental and ecological destruction. This is largely based on business oriented approaches for sustainable development and does not necessarily include the importance of deep philosophical change required to inform the design of strategies to promote sustainable development. However, the Green Economy is a popular buzz word used in the Western Cape Province to justify strategies taken to attempt to promote renewable energy development there.

10. Sustainable Development

Sustainable development is an ambiguous concept with multiple interpretations. According to the Bruntland report, sustainable development refers to “ ... development that meets the needs of present generations without compromising the ability of future generations to meet their needs” (WCED 1987: 43). This report first

brought the term *sustainable development* into the political sphere at the World Commission on the Environment and Development (WCED). This commission highlighted issues of ecological degradation, inequality and poverty, and the attempt to reconcile economic and environmental goals while prioritising the importance of human needs (Mebratu 1998; Hattingh 2001). The aim of these policies was to ensure an equal, sustainable distribution of the earth's resources to improve the quality of life of people in developing countries, as well as to maintain the high standards of living for people in developed countries (Hattingh 2001). The UNEP provides a more updated interpretation, with 17 sustainable development goals that show that the idea of sustainable development has to do with integrating the design of energy, infrastructure, transport, agricultural and economic development objectives, and aligning them with aims to promote environmental healing and well-being as well as social equality. The concept has also been interpreted in more shallow ways and used to green wash business-as-usual, but after completing the PGD in sustainable development, my interpretation of the concept is that it refers to more fundamental changes in the way current development is planned and conducted, as well as changes in the paradigms that inform research for the design of this development towards more ethical practices in line with the 17 UNEP goals for sustainable development. This concept is discussed in far more detail in chapter 5, where it is triangulated with the research findings to provide recommendations for future research.

11. Systems thinking

Systems thinking refers to the recognition that everything on earth is connected in some way because living and non-living entities are embedded within systems and interact with each other. Living systems, according to von Bertalanffy (1950), are open systems. These are systems that interact with and are affected by changes in other systems, as well as the broader environment and energy flows through these systems to maintain life and allow for the existence of emergent properties. They function to maintain the stability of the system and work towards but never achieve

equilibrium, as equilibrium is equated with the death of the system. Systems thinking informs an alternative paradigm and approach to knowledge generation to that of modernity and reductionist, Newtonian science, and offers insight into where to begin when designing strategies to promote sustainable development. This way of thinking is also explained in more detail in chapter 5.

12. Complexity Theory

Complexity Theory is based on Systems Thinking and refers to the theory that informs suggestions for how to analyse, understand and generate knowledge from the study of these systems and their interactions. Complexity is the essence of the system and can only be revealed if the system is viewed holistically, as it disappears when one attempts to understand the system by breaking it down into its basic parts and examining each part in isolation of others. The idea of *emergence* is also of central importance to complexity theory because it refers to information, insights, understandings and phenomenon that arise as a result of the interactions between the various actors in systems and the effects of broader systems on smaller ones (and vice versa). This theory is integral to the development of knowledge that can be used to inform true (rather than shallow) interpretations and strategies that promote sustainable development. Strategies informed by complexity theory usually involve dynamic systems modelling, facilitated stakeholder interaction, and transdisciplinary research. This concept is also explained in far more detail in chapter 5.

13. Neoliberalism

Neoliberalism refers to a "...set of political beliefs which... include the conviction that the only legitimate purpose of the state is to safeguard individual liberty, understood as a sort of mercantile liberty for individuals and corporations" (Thorsen, 2010: 203). The state therefore has limited influence over economic activity except to ensure the safety and security of environments and markets for these activities to

operate in. A drawback to this approach to governance is that “poverty and inequality and moral injustice” are rife, normalised and accepted because the situations in which people find themselves are widely considered to be the results of all their choiced that they had the freedom to make and not the fault of anyone or anything else (Thorsen 2010: 200). In a Neoliberalist system, it is not considered the State’s role to assist poverty stricken communities by providing healthcare, education, resources and amenities or to assist with employment creation as it is within a governmental system based on socialist principles.

1. Chapter 1 – Introduction

“The way means inducing the people to have the same aim as the leadership, so that they will share death and share life, without fear of danger.”

-Master Sun Tzu, The Art of War

a. An Introduction

Energy is essential for life, and electricity has become essential to modern living: it enables more efficient ways for people to conduct daily activities, allowing us to increase the number and quality of activities that we do in perpetual pursuit of more profits, comforts and appliances – which will ultimately save us more time. Unfortunately, energy generation and consumption at this scale has done, and continues to do, serious damage to the natural environment – which essentially supports life on our planet. To date, deciding which need to prioritise has, surprisingly, proven rather difficult for us and has led to much debate over the last couple of decades.

One such debate is on how to decouple development from increasing resource consumption (UNEP 2011). With reference to electricity generation, the debate exists as to whether or not moving from having purely centralised electricity generation systems to having systems that include distributed generation technologies will help countries to meet increasing demand for electricity, while decreasing the strain on the natural environment that current, centralised and conventional power systems exert. Many authors have researched the benefits of distributed generation over centralised generation and note that this is essential for the future development of electricity systems, although finding ways of successfully

integrating distributed generation (DG) technology systems into centrally structured electricity systems presents many challenges (Bayod-Rújula 2009; Alanne et al 2010; El-Khattam & Salame 2004).

South Africa has a centralised generation system that mostly relies on coal-fired power generation systems and presents significant technical, financial, policy and logistical barriers to any kind of DG systems that would need to be connected to the distribution network. While many policies and plans exist at national level that support sustainable, integrated development, and recognise the need for an increased diversification of the electricity generation, therefore promoting renewables, there is no policy, at this level, to enable and guide the uptake of DG or small-scale embedded generation (SSEG). The integrated Resource Plan (DoE 2010) has also not been updated and therefore there is a significant policy gap where the future development of the country's electricity system is concerned. Much of the debate in South Africa is dominated by the discourse around SSEG, particularly small-scale rooftop photovoltaic (PV) systems and how municipalities should proceed to enable this practice in the absence of policy guidance.

In this thesis, I explore the discussion about the uptake of SSEG PV systems at municipal level in South Africa. In order to broaden the discourse on SSEG and DG in general, I aim to include the voice of a largely neglected stakeholder in the discussion pertaining to the FiT scheme in Stellenbosch, the homeowner. I began this research process with the following question in mind: *why is there such a strong focus on the uptake of residential scale solar PV systems in South Africa?* My gut feeling was that the prioritisation of SSEG (embedded PV) was limited given all the various creative and exciting DG projects that have been experimented with elsewhere. This research project therefore aims to examine this approach in more detail, using a single, detailed case study conducted in Stellenbosch, Western Cape, and comparing the findings to those revealed in a desktop study conducted to briefly examine a selection of case studies exploring the different approaches taken towards DG in other developed and developing country contexts. For the purpose of

this study, I take a broader view on the interpretation of DG to be an umbrella term that includes various types of systems, including those as small as SSEG (such as embedded rooftop PV systems). I use the term DG when referring to alternative approaches to the conventional centralised generation systems, and SSEG to refer specifically to embedded rooftop PV in the South African context, bearing in mind that stakeholders in South Africa have primarily only engaged with the idea of embedded DG in terms of how embedded rooftop PV can be enabled.

I interrogate the effectiveness of the feed in tariff (FiT) scheme proposed by local governments in terms of the scheme's ability to adequately contribute to SSEG development for sustainability. This is done with particular reference to a case study conducted in Stellenbosch that examines the Stellenbosch Municipality's recent proposal of the Self Generation of Electricity and Feedback into the Stellenbosch Municipal Grid Policy 2015/2016 (Stellenbosch Municipality 2016a) that enables a FiT scheme to homeowners. In order to broaden the discourse on SSEG and DG in general, I include the voice of a largely neglected stakeholder in the discussion pertaining to the FiT scheme in Stellenbosch, the homeowner.

b. Background: The South African electricity system

Krupa and Burch (2011: 6257) necessarily explain that "...energy is a sensitive and politically charged topic in South Africa." The dynamics at play in this system serve to complicate the electricity space and present significant barriers to the uptake of renewable energy (RE) systems as well as decentralised or DG systems. I start off by discussing the various voices that participated in energy and electricity-related debates, after which I describe the nature of the electricity system at municipal level in South Africa and how it is changing as a result of the debates between these actors.

The debates about mechanisms to facilitate transformation in the South African electricity sector (from the current, unsustainable situation to a more just and

sustainable one) involve three key sets of voices. These include the national government (through policy), businesses (international and national and both in the RE and conventional electricity sectors), and the non-governmental organisations (national and international). Each group has various agendas and beliefs about what this transition might look like, and the dynamic set of actions that occur as a result have been described as “disjointed” (Krupa & Burch 2011). One voice is missing, however, and that is the voice of the consumer. Unfortunately this creates an atmosphere of instability and generates feelings of mistrust amongst potential stakeholders and investors. This, according to Krupa and Burch (2011), forms the ideal context for the emergence of transitions for sustainability.

Similarly, Büscher (2009) highlights that the literature on the topic of the uptake of RE in South Africa can be seen as written from two main perspectives.

On the one hand there is the general perspective that RE systems should be used to provide affordable access to electricity for all South African citizens regardless of race or socio-economic status. This perspective is supported by the South African Government, run by the African National Congress (ANC), and is reflected in policies such as the National Development Plan (DoP 2012) and supported by authors such as Winkler (2005), Musango (2013), Amigun et al. (2011), Pegels (2010) and Walwyn and Brent (2015).

While these policies aim to alleviate poverty and inequality (historically promoted under the Apartheid regime) and to promote equal access to resources, Spaulding-Fetcher and Williams (2000) and Brent, Guy and Mosdell (2012) show that there is little integration (at national policy level) between social development goals and goals for the uptake of RE systems. Sebitosi and Pillay (2008) also show that there is a lack of political will in South Africa to implement concrete strategies for the promotion of RE systems despite their potential benefits. This means that, while South African policies are quite progressive, there are significant challenges to their successful implementation.

On the other hand, as Büscher (2009) explains, is the perspective that focuses purely on the issue of securing sustainable energy supplies, preferably from promoting the uptake of new renewable and green energy technologies. Various actors and stakeholders in the RE market and private sector, as well as some political parties in South Africa, promote this strong neoliberal standpoint. Simply put, this perspective includes the belief that modern technology is capable of managing the problems that have emerged from older generations of technologies. This is provided that the new technology or technological systems are promoted on the market and that their uptake is thus increased, as a strong market can lead to other benefits such as job creation.

Although market initiatives can be beneficial, this approach is also limited for a number of reasons. One main reason is that this perspective fails to consider the socio-economic or political aspects of the energy system in South Africa beyond those that will affect market dynamics. This approach is therefore based on profit-driven, rather than by integrated, social and environmental development goals. This approach serves to perpetuate socio-economic inequality because the aim is to find ways of selling expensive RE systems to customers who can afford them, with little consideration of those who cannot (Büscher 2009).

Büscher (2009), Baker et al (2014) and Krupa and Burch (2011) all acknowledge the limitations of these two perspectives, and suggest a third perspective from which to view and understand the dynamics of the energy system and the transition towards a more sustainable energy system in South Africa. This perspective makes an effort to acknowledge the political-economy of energy in South Africa and how it could respond to calls for a transition.

Baker et al (2014) emphasise that this transition is still in its early stages of development and use the multi-level perspective to reveal how actors at each level (landscape, regime or niche) influence decisions, thoughts and actions on the next.

The unique South African electricity context is described from this perspective below, before the problem that inspired this research is revealed.

**i. The Foundations of the South African electricity system:
The Minerals and Energy Complex (MEC)**

Baker et al (2014) describe South Africa's electricity system as being "... characterised by its unique social, political and economic legacy of Apartheid which continues to impact the contemporary politics of energy transition in profound ways.". The MEC was designed to drive the economy by providing large amounts of cheap electricity to mines, industry, business and the privileged minority and racist, Apartheid infrastructure also ensured that the electricity was distributed to privileged minorities, leaving areas that were designated to the disadvantaged majority with little to no access at all. This helped cement poverty and inequality in society and is still evident in today as extending grid infrastructure is expensive and slow and a lack of access to electricity is still an issue in poorer areas. Baker et al (2014) therefore also emphasise the challenge of inequality is central to electricity transformation discourse in the country.

The MEC narrative is relevant to this discussion because of its role in reinforcing poverty through an unequal distribution of resources (electricity) and a transition in the electricity sector would need to address such inequality if sustainable development is the aim. The structure of the MEC, as well as its central role in supporting the economy, also presents significant barriers to the uptake of renewable energy systems. This is addressed at National level, to some extent, with the REIPPP programme, however, still remains an obstacle to the uptake of small to medium renewable energy alternatives, especially at municipal level in South Africa (Baker et al 2014). The question that emerges is therefore how to manage smaller RE transitions at local levels that can manage, and address challenges presented by the

prohibitive structure of the MEC and the monopoly over the electricity market held by Eskom. Some of these challenges are discussed in more detail below:

South Africa has a centralised electricity generation, transmission, and distribution system that is heavily reliant on a number of large-scale coal-fired power stations, which, historically, were able to supply the country's electricity consumers with large amounts of cheap electricity (Baker et al 2014). This centralised electricity system was designed to support the country's economy, based on the "minerals energy complex" (MEC) model, to support increased economic growth (measured by Gross Domestic Product or GDP) and has been heavily criticised because of the limitations surrounding the use of GDP as a primary measure of progress.

In his MBA, Theo Covary (2006) highlights the problems related to the prioritisation of GDP as a measure of growth because this measurement does not distinguish between 'good growth' and 'bad growth'. Bad growth is growth that is also detrimental to the environment and to society, and Covary (2006) strongly argues that increased growth based on increasing electricity generated from fossil fuels is accompanied by high social and environmental costs due to the damage caused by increased release of GHG into the environment – a point echoed by Spaulding-Fetcher and Matibe (2003).

Under this model, economic growth is fuelled by large amounts of cheap electricity, required to supply both mining and industrial processes. Increased economic growth between 2002 and 2009 meant that by 2009 South Africa had become the "sixth largest producer of coal" in the world in order to meet the increasing electricity demand from residential, industrial and commercial sectors (Krupa & Burch 2011: 6254). Eskom is responsible for the generation, transmission and distribution of 95% of the country's electricity supply and therefore enjoys a monopoly over the South African electricity market (DoPE 2014). While this may have been good for increasing GDP and economic growth in the country, South Africa also became Africa's largest GHG emitter, contributing to air pollution and climate change.

This centralised electricity generation model is therefore considered successful, as GDP, one of the most important measures of success in the modern world, had, by 2009, significantly increased. This economic growth rate, however, proved to be unsustainable in the years following the 2008 global financial crisis.

ii. The unsustainable nature of the MEC

This resource intensive economic growth model proved unsustainable for a number of reasons both internal and external to the South African electricity system and economy.

The 2008/ 2009 global financial crisis generally had a negative effect on the rate of economic growth internationally. However, the effect this had on South Africa was less serious and showed that “...the contemporary capitalist world order is becoming increasingly unstable...” (Krupa & Burch 2011; Büscher 2009: 3951). While South Africa did not bear the brunt of the recession in the same way Europe and America did, the recession and almost simultaneous culmination of Eskom’s various problematic crises served to highlight the unsustainable nature of the country’s electricity system and its ability to promote similar levels of economic growth going forward.

Prior to the financial crisis, Eskom’s fleet of aging coal-fired power systems began to fail, and South Africa experienced a nationwide shortage of electricity. Eskom thus implemented regular load shedding in 2008 in an effort to prevent grid collapse (Büscher 2009). In order to try and solve the problem, Eskom has, over the last few years, requested and implemented a series of electricity tariff hikes approved by the National Energy Regulator of South Africa (NERSA). Electricity prices were set to rise by 25% between 2010 and 2013 and a further 8% per year until 2018 (Baker et al. 2014: 792). The economy, originally based on the supply of cheap electricity,

has suffered as a result of increasing electricity prices. Load shedding is a practice that continues to play a role in electricity supply management today, with the most recent residential load shedding taking place throughout the winter of 2016.

South Africa's energy intensive economic growth model caused the country to become Africa's largest greenhouse gas (GHG) emitter (Carbon Disclosure Project 2011). This became recognised as a major issue both locally and internationally due to increasing recognition of the significant consequences of climate change, and of the importance of engaging with issues of sustainable development (Brent et al 2012). Thus, the South African government made some commitments to reduce reliance on coal-fired power and further diversify the national energy mix by increasing the amount of RE generated. This issue contributes to the growing need for a transition of the electricity system in South Africa towards a more sustainable, greener and more reliable system and the incorporation of renewable energy systems has been identified as key to managing this complex problem.

In 2009, South Africa made commitments to reduce carbon emissions by 44% by 2025, from the 2008 baseline measurements (Baker et al 2014). This added further pressure on both Eskom and the South African Government to engage in discussions for change where the electricity system was concerned. There was the recognition that RE systems may be a more affordable way of increasing electricity supply capacity as well as of decreasing the country's carbon footprint, and thus help turn a largely unsustainable system into a cleaner, more sustainable one.

iii. Promoting RE in South Africa

Various national policies exist that speak to the promotion of sustainable, integrated development and RE. Briefly these are:

- The New Growth Path (2010), which includes targets for job creation and renewable energy generation (Brent et al 2012: 27)

- The Integrated Resource Plan, which projects the amount of energy required in the future and what proportion of this will be supplied from RE generation (Brent et al 2012: 27)
- The Industrial Policy Action Plan (IPAP and IPAP 2) and South Africa Renewables Initiative, which aim to secure funding for renewable energy projects, support development projects that mitigate climate change, and create space for private sector involvement and cooperation for projects that support the development of a greener economy (Brent et al 2012: 27)
- The National Development Plan (NDP) (2011), which aims to move South Africa away from the unsustainable consumption of resources and promote efforts to reduce carbon emissions while promoting economic growth and extending electricity access to previously disadvantaged areas (Brent et al 2012: 27)

In an effort to address the electricity supply shortages, to reduce the country's GHG emissions, reduce poverty and inequality, and to encourage investment in the struggling economy, the South African Government committed to reducing "...GHG emissions by 34% by 2020 and 44% by 2025", and to include 10 000 GW of electricity from renewable sources to the national energy mix by 2013 (Baker et al. 2014; DME 2003). This document served to officially mark the beginnings of a transition for a more sustainable energy system for South Africa.

In order to meet this RE target, the government and Eskom investigated alternative options for electricity generation and looked into various ways of funding these projects. A number of market, finance and policy tools were designed to incentivise development in the sector – the details and analysis of which are beyond the scope of this paper but can be found elsewhere (DME 2003; Brent et al 2012). Even though the 2013 deadline for meeting the target was missed, an innovative financing

model was developed through the Renewable Energy Independent Power Producers Procurement Programme (REIPPPP or REI4P). This is the first funding scheme of its kind in the international RE space and is monitored with interest by the international community.

This programme was designed by policy makers to set a cap or quota of electricity generation capacity from RE systems, such as solar, wind and biomass, between 2010 and 2030, pictured to the right. This is only for the construction of utility scale generation systems. The idea is to involve the private sector in a bidding process where the project that meets the set of

project criteria and with the lowest electricity price secures the bid and can feed electricity generated to the national grid with a FiT (Minnaar 2016). A bidding round for smaller projects of between 1 and 5MW was announced in August 2013 (DoE 2015) and the successful bidders of the first Stage Two submission were announced in October 2015 (DoE 2015). While the REIPPPP has enjoyed much success, it only provides guidelines for

the uptake of utility or large-scale embedded RE systems and does not include a discussion on the uptake of SSEG (Walwyn & Brent

2015). SSEG, with or without the micro/smart grid, is a model of energy generation that is widely considered as a favourable component of transitions for sustainable energy systems elsewhere in the world.

This target is broken down to:

- **14 725 MW** of renewable energy (comprising of solar PV: 6 225 MW, wind: 6 360 MW, CSP: 1 200 MW, small hydro: 195 MW, landfill gas: 25 MW, biomass: 210 MW, biogas: 110 MW and the small scale renewable energy programme: 400 MW);
- **6 250 MW** designated from coal-fired plants (including 3 750 MW from cross-border projects);
- **1 800 MW** of cogeneration;
- **3 726 MW** of gas-fired power plants; and
- **2 609 MW** of imported hydro.

Figure 3: Breakdown of the renewable energy caps for each type of generation system under the REIPPPP (Source: IPP Projects 2016)

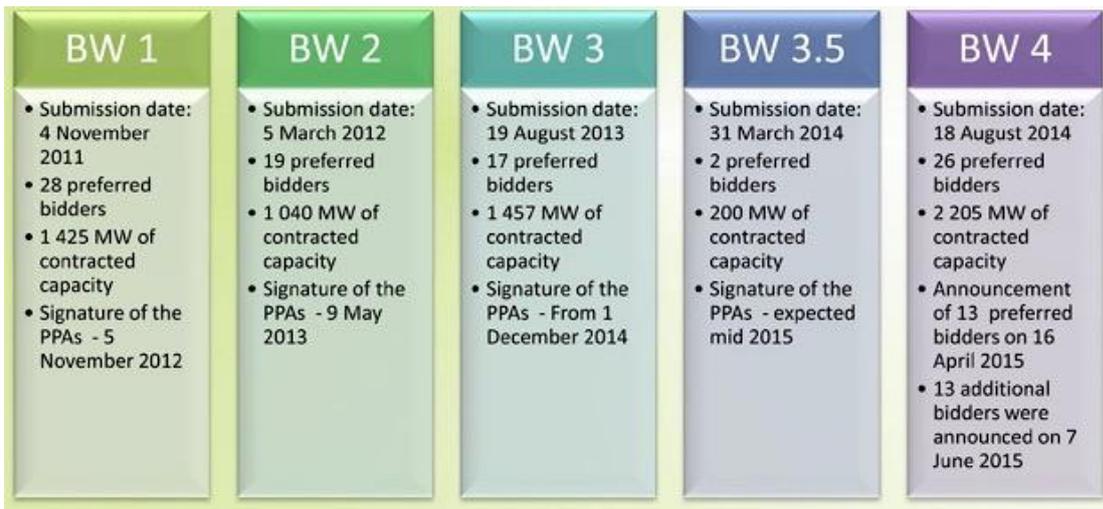


Figure 4: Capacity allocations for renewable energy in each bidding window under REIPPPP (Source: Fin24 2015)

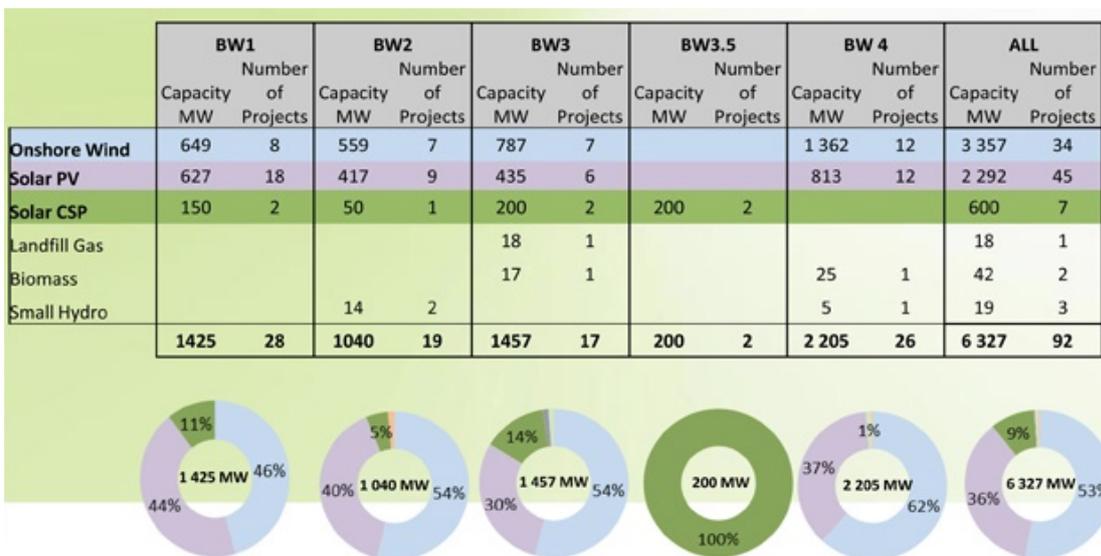


Figure 5: Accepted capacity of each type of RE technology for each bidding window (Source: Fin24 2015)

iv. SSEG in South Africa

The transition narrative raises many questions for how to manage the challenges it presents at various levels of society. At national level, The REIPPP programme serves to guide activities, however, little guidance is provided for local endeavours to promote renewable energy uptake.

A review of the policy space regarding the uptake of RE in South Africa revealed two key points:

1. In addition to the fact that the REIPPP has only recently considered small-scale Independent Power Producer (IPP) projects (also known as DG projects), the issue of the uptake of SSEG has largely been ignored.

2. There is evidence to suggest that there is a call for SSEG in South Africa that is gathering momentum (Reinecke et al 2013). However, governments at both national and local level have been hesitant to engage on this matter (Reinecke et al 2013). This call is largely for one type of SSEG system: residential and commercial scale solar PV systems.

v. The focus on the uptake of residential SSEG PV systems in South Africa

I have briefly explained the history and nature of the South African electricity system in terms of its political-economic context to indicate why a transition for a more sustainable electricity system is necessary in South Africa and how this is being approached at national policy level. Now, I turn to a brief discussion of the response to the electricity crisis from local government as well as from the middle and upper income electricity consumer.

One of the key drivers of SSEG is the continued load shedding from 2008 through to 2015, most notably during the winter months. The inconvenience of load shedding had citizens scrambling for any alternative source of energy or storage that was affordable to them, and those who could afford it invested in solar PV systems. Many who could not afford batteries, and who owned the conventional disk meter, simply connected their PV systems to the grid (illegally) and allowed their meters to spin backwards, significantly reducing their electricity bills. This therefore proved advantageous (although it does not really assist with load shedding per se) (Reinecke et al 2013). Various municipalities, such as Drakenstein, the City of Cape Town (CCT), eThekweni, Ekurhuleni and the City of Johannesburg, have since provided regulations for grid connected PV, however, many voice concerns that the uptake of rooftop PV has been limited (Reinecke et al 2013; Wicht 2016).

Reinecke et al (2013) is one such party concerned with promoting the uptake of rooftop PV by promoting FiT schemes to incentivise homeowners to invest in embedded solar PV systems. Depending on the structure of this FiT, it could make the purchase of a solar PV system more economically viable and help reduce the pay back period on the investment. This also eliminates the need for homeowners to invest in costly storage systems such as batteries, that usually have toxic chemicals in them. After much research and discussion, various municipalities (such as the Stellenbosch Municipality, Drakenstein Municipality and CCT) have conceded to the requests for SSEG tariffs. Both the CCT and Drakenstein municipalities have made the relevant policy changes to enable FiT schemes, while Stellenbosch Municipality has recently released the policy and tariff suggestions for public comment. Despite these concessions made by the municipalities, the uptake of residential scale solar PV systems is lower than expected (SALGA et al 2016). For a list of all the municipalities who allow SSEG and their stages of development of tariffs and policies, see Table 1.

Table 1: Municipalities in the Western Cape that are in the process of enabling, policy guidelines for the uptake of SSEG PV (Source: GreenCape 2016)

#	Municipality	Allow SSEG	SSEG tariffs	SSEG policies
1	Beaufort West	Yes	Yes	In progress
2	Bergrivier	Yes	No	In progress
3	City of Cape Town	Yes	Yes	Yes
4	Drakenstein	Yes	Yes	Yes
5	George	Yes	Yes	Yes
6	Mossel Bay	Yes	Yes	Yes
7	Oudtshoorn	Yes	In progress	In progress
8	Overstrand	Yes	Yes	In progress
9	Stellenbosch	Yes	Yes	Yes
10	Swartland	Yes	Yes	Yes
11	Theewaterskloof	Yes	Yes	Yes
12	Langeberg	Yes	Tariff consultant appointed	Yes
13	Breede Valley	Yes	In progress	No

Table 2 shows an overview of the installed SSEG PV capacity to date, showing limited uptake despite the SSEG guidelines released by municipalities.

1. Overview per province

Province	Keeping track of existing installations	Official application system	Approved SSEG tariffs	Number of installations	kWp installed	Average size (in kWp)
Eastern Cape	2	2	1	154	1,302	8
Gauteng	3	2	1	9	4,505	501
KZN	1	1	1	18	70	4
Limpopo	2	0	0	3	265	88
Western Cape	13	11	9	301	8,887	30
North West	1	0	0	10	2,000	200
Mpumalanga	0	0	0	-	-	-
Northern Cape	1	0	0	4	183	46
Free State	1	0	0	3	400	133
TOTAL (Aug 2016)	23	16	12	495	17,029	34
PAST DATA to track progress						
TOTAL (Feb 2016)	10	3	5	264	9,044	34

Table 2: Overview of SSEG PV uptake by province (Source: SALGA, GIZ, German Cooperation, AMEU & GreenCape 2016)

I therefore began this research project in Stellenbosch in 2014 with the aim of investigating why the uptake of solar PV systems in the municipality is limited, despite efforts made by the municipality to respond to demands made by the private sector. I had heard rumours of how SSEG PV systems had the potential to alleviate the generation capacity crisis that Eskom was experiencing and therefore alleviate the load shedding that affected all South African citizens. I had also been given a bursary by the Centre for Renewable and Sustainable Energy Studies at Stellenbosch University and was supported to try to find a way of using my social sciences background to provide a different perspective on unlocking the rooftop solar PV market in Stellenbosch. I was keen to provide research that would be useful to my bursary providers and spent a lot of time trying to work out how my research could fit in with, and build on, existing research on the topic.

My original enthusiasm for the topic faded over time, however, as I began to learn more about the actual and potential complexities, and limitations that accompanied the idea of SSEG PV systems. I began to feel uncomfortable with this research topic as I realised that the cost of PV systems represented a significant barrier to their uptake, and presented a very realistic limitation to the extent to which residential scale PV systems could alleviate generation capacity crises or load shedding for anyone unless they invested in batteries for themselves. This is because the extent to which the uptake of residential solar PV could serve a role in the transition towards a sustainable electricity future for Stellenbosch residents is limited, as the costs potentially prevent the participation of low income households- an issue that is not addressed in the emerging policy either.

The realisation that the collective benefits to the uptake of PV systems were so limited was jarring. I began to feel extremely uncomfortable with my chosen topic, because of its blatant focus on investigating the effectiveness of a policy that ultimately serves the interests of wealthy residents. This felt extremely unethical because of my socialist beliefs and their implications for my understandings of what the role of a 'government' includes. This feeling of discomfort was exacerbated by

the fact that I was living in Stellenbosch, a town where socio-economic inequality is still heavily associated with race, and where I would expect there to be more (and not less) effort put into promoting integration and equality. These issues are discussed in more detail in a description of the case study provided in chapter 4, but I have mentioned them here because they were vital to the development of my research topic.

Further investigation revealed another key aspect of my problem with the proposed research angle. I found very little empirical research to show that residents in Stellenbosch were thoroughly consulted about their interest and/or ability to invest in SSEG PV systems for their homes. There is therefore a gap in the research that required further investigation because such an investigation has the potential to provide information to inform decision making when designing and promoting policies to guide and change the electricity consumption and generation behaviour of local residents.

c. Problem Statement

The insight into the complexity surrounding the management of a transition towards a more sustainable, greener electricity system in South Africa and around what role SSEG at local level should play in such a transition, shows that two problem areas emerge. The first is that national government objectives are unclear in terms of how the uptake of DG and SSEG should be managed in general in South Africa. The second is that, in addition to an absence in policy guidance, in some areas, such as in Stellenbosch, there is an absence of engagement with potential consumers of SSEG, and, that the development of the FiT policy appears not to have been informed by such stakeholder input. These are now explained in more detail below.

The first problem hinges on the emergence of doubt that surrounds the government's commitment to sustainable development outlined in policies at national level, especially where the future development of the country's

unsustainable electricity system is concerned. This is because, while some policies exist to promote the increased diversification of the national energy mix, little success has been made to enable a more radical change the unsustainable structure of the electricity system (and MEC).

There has also been little guidance provided at national level for how local governments should implement policy objectives for sustainability on the ground, and none at all for how municipalities can harness the potential benefit of DG or SSEG systems to cope with, and contribute to: the alleviation of global climate change, the national level electricity security crises (and increasing electricity prices), and to respond to local needs for electricity access and the need for greater energy and electricity security.

The second problem is at the local level – in general, Johan Coetzee (2015) of the Stellenbosch Municipality explains that municipalities are struggling to implement their service delivery mandates, particularly where electricity services are concerned because of the crisis facing the centralised national electricity utility. In addition to this, there are initiatives driven by various stakeholders to promote the uptake of SSEG. Municipalities therefore find themselves between the proverbial ‘rock and a hard place’ because their mandates and funding are issued by national government and guided by national policy (the rock), and the movements from citizens, business and non-government organisations (NGOs) (the hard place) who are calling for alternative electricity models to ensure electricity security in the face of crises at, and mistrust of, national government (Coetzee 2015).

Despite attempts to engage with these issues by a number of municipalities and other stakeholders, the actual uptake of PV systems at the residential scale has been limited. This suggests that there has been an assumption made about the needs of electricity consumers at the residential scale and that these needs could ideally and easily be met with the provision of a FiT to enable the uptake of embedded rooftop

PV systems. I specifically use the term “assumptions” because more research is required to determine the reasons. The problem statement is therefore as follows:

There is little evidence to suggest that the Stellenbosch Municipality consulted does local homeowners on the issue of grid connected solar PV technology in terms of what their opinions on the technology and on the FiT that has been recently designed and released and that such information was used to inform the design of the FiT provided.

This calls into question what the Stellenbosch Municipality aims to achieve with the FiT in terms of who is meant to benefit, and, how the scheme is intended to contribute to the facilitation of a transition towards a more sustainable electricity system.

The actual problem is, of course, more complex but the above statement serves to define the parameters of, and provide guidance and direction to, this investigation.

d. Research Question, Aims and Objectives

This study aims to investigate and critically evaluate the effects of the approach taken towards the uptake of DG systems in Stellenbosch, South Africa, against approaches taken elsewhere in the world to determine the extent to which the approach is appropriately geared towards the development and management of a transition towards an electricity system that incorporates more SSEG systems and RE technology.

The primary focus of this research is to begin a discussion between the Stellenbosch Municipality and other relevant policy makers and the local residents on the issue SSEG and best to manage the uptake of embedded solar PV, given the benefits and limitations of the systems.

The research question therefore focuses on how residents would respond to an attempt to include them in a discussion that aims to gather information that could inform a policy and decision making process, what they may have to contribute, and on how their feedback on a decision could be useful to decision makers. It is not simply an attempt to uncover what participants think about SSEG PV but rather to gather more information on whether or not residents in Stellenbosch would participate in the opportunity to feed excess electricity back into the grid and, if not, to question the usefulness of the policy itself.

I therefore conduct a case study within the boundaries of the Stellenbosch Municipality to provide a glimpse into what some Stellenbosch residents think about solar PV and what their opinion on the FiT offered by the Municipality is. An analysis of the emerging themes gathered from the discussion is conducted with the aim of understanding how this information could be useful to the design and management of a transition towards the uptake of SSEG in the Stellenbosch Municipality, how this compares to what has been done elsewhere in the world, and where opportunities for future research to inform future decision making could lie.

The primary research question is therefore as follows:

What do residents in Stellenbosch think about the idea of investing in PV systems for their homes with the feed in tariff and policy, recently released by the Stellenbosch Municipality, that enables them to sell their excess electricity back to the local municipality?

In the case study, I aim to gain a better understanding of whether homeowners understand the details around making such an investment and whether or not their responses are well informed. To gain this insight, I have put together six sub questions. The homeowners are referred to (in the questions below) as the ‘participants’, as the answers provided in chapter 5 are specifically in relation to the

insights that the participants (who were all homeowners in Stellenbosch) provided. The objectives are to answer the following research questions:

- What do participants think about the idea of investing in PV systems for their homes?
- Is embedded PV with a FiT something participants specifically need or want?
- Do participants understand the costs and implications involved in becoming more energy independent?
- Why would participants consider investing in a solar PV system? If not, why not?
- Do the participants like the idea of having a FiT and would this make them more partial towards investing in a PV system?
- What effect would the process of providing participants with more information on the costs, implications, benefits, drawbacks and opportunities have on their attitudes or opinions towards the idea of investing in rooftop PV systems?

For broader contextualisation of the issue, I am also interested to know how other countries have dealt with issues surrounding the implementation of DG and SSEG (particularly rooftop PV) and thus the secondary research question is:

How does the South African approach to SSEG compare to approaches taken elsewhere in the world?

The two related sub questions are:

- To what extent have these been successful?
- What aspects do the successful examples have in common?

The theoretical content that underpins the approach taken to this study is informed by Sustainable Development (SD) and Complexity Theory literature. Central to this approach is the acknowledgement of the importance of complexity when engaging with the idea of emergence, as well as in acknowledging the complexity of transitions for sustainability that cannot be simplified. Rather, emphasis is placed on the need to be managing these transitions with the generation of a different type of knowledge that is more useful to such endeavours. I suggest that this paper presents the first step towards generating more useful information for policy makers aiming to genuinely support sustainable development as defined in this paper (in the definitions section and in chapter 5). Chapter 5 also includes a discussion on how insights gained from this study can be useful for managing transitions for sustainability.

Frank Geels (2010), for example, suggests the use of the multi-level perspective as one such alternative knowledge generation tool to use when conducting research to inform policy making. Schäfer et al (2011) specifically refer to the importance of transdisciplinary research as a method for promoting the successful implementation of decentralised generation systems in rural areas as a more radical way of managing the lack of grid supplied electricity to these areas. Schäfer et al (2011: 324) maintain that the “central means towards success in this domain include embedding the introduction of technical systems in a range of services (e.g. capacity building, maintenance, repair and disposal services, financing schemes), integrating users' needs in their development and implementation, enhancing productive use of electricity by linking energy supply to regional development programs. To be able to deal with the outlined questions, the perspective of decentralized energy supply as socio-technical systems can be helpful. Research desiring to adequately meet the challenges needs to integrate knowledge and perspectives from different disciplines as well as expertise from practitioners in the field in a reflective manner.”

Phillipson et al (2012), on the other hand, discuss the existence of a number of other research strategies that promote public (or consumer) engagement in the research

process, especially for generating knowledge to inform policy development. Phillipson et al (2012) therefore argue that conducting fully participator or transdisciplinary research is not the only way to promote stakeholder engagement in research design by reflecting on the rich interactions that occurred around a survey designed and conducted in the UK on rural land use. Stakeholder interaction can also be achieved and promoted when designing more structured, systematic approaches to research. I take a similar approach where I promote stakeholder engagement through implementing a more structured mixed methods research approach because of resistance I experienced and witnessed to suggestions of a more participatory approach (lack of cooperation with the Infrastructure Innovation Committee (IIC) in Stellenbosch – to be discussed in more detail later).

My overall aim is to triangulate the emerging results of my case study with:

- The theoretical lens through which I have decided to view the complexity of the electricity transition in South Africa (provided throughout this chapter); and
- Findings from the investigation into the various approaches taken towards the uptake of DG elsewhere in the world (presented in chapter 3, the literature review).

In summary, this study therefore aims to:

- Take the first step in initiating discourse between the Stellenbosch Municipality and other relevant stakeholders and local residents on the issue of the uptake of embedded rooftop PV systems and the FiT structure and to see what emerges from the discussion
- Use the concept of emergence from complexity theory and thematic analysis to determine how the findings can be useful to inform municipal decision

making by making policy recommendations and by identifying opportunities for future research

- Assess the extent to which the drive for the uptake of PV systems can be considered able to contribute to a transition for a truly sustainable electricity system in South Africa's future in comparison to how governments in other countries have attempted to manage this process or transition.
- Investigate how this approach compares to approaches elsewhere in the world.

e. Research Design, Methodology and Methods

This study falls into the category of what is widely known as applied research because it involves an inquiry into a current issue involving many different stakeholders and their interactions on the topic of SSEG in South Africa (Bryman et al 2014). The findings could also be useful to policy and decision makers in the field of RE and SD in South Africa, particularly at local government level.

I initially thought that designing and conducting a survey would be the best way to gather the data I needed. This changed, however, as I came across an increasing number of obstacles that tend to present themselves to researchers who try to take objectivist approaches to research topics that would greatly benefit from more positivist approaches. As my research process progressed, and despite the work I had already done, I accepted that the survey was not going to work. It is impossible to design a short survey capable of gathering useful data when one cannot assume that potential participants have enough knowledge on the subject to answer the questions in an informed way, nor did I feel that I could rely on the ABC model on the attitude-behaviour relationship (that I would've borrowed from the field of psychology) to provide a framework for interpreting my results in a meaningful

way. Shove (2010) also writes about the limitations of the ABC model in terms of its ability to inform strategies for the promotion of social change, particularly in relation to policies for sustainable development in the UK.

I then realised that more relevant data could be gathered by using a mixed methods approach. I searched for a methodology that allows for the acceptance of – and engagement with – complexity, and that allows for the consideration of a broader understanding of the problem. I also looked for the best way to analyse and report on the data gathered. After much deliberation, I decided that the best way to analyse the data is through a process of triangulation, because triangulation represents “...a valid way to understand complex social realities...” (Bryman et al 2014). As I explained in the previous section, complexity theory is a central component of the lens through which I viewed and approached this study. One aspect of complexity theory that is relevant here is the discussion about the perception of an interconnected reality from a perspective of complexity, as opposed to reductionist perceptions of reality informed by a modernist paradigm. The former perspective is more flexible and plural in terms of what can be considered knowledge, and thus connections and interactions become important topics of research and legitimise the use of such knowledge to inform policy and future research endeavours. Olsen (2004: 24) suggests the use of triangulation as a way “...across the qualitative-quantitative divide [and that triangulation] is only consistent with a pluralist theoretical viewpoint”, which I have chosen to be informed by complexity theory and systems thinking.

i. Mixed methods research

I chose to conduct a mixed methods research for a number of reasons:

1. Limited opportunity for participatory or transdisciplinary research approach

Given my interest in systems thinking and complexity, one might wonder why I did not opt for a research approach and methodology that would allow for a greater consideration of complexity, such as a transdisciplinary, participatory or dynamic systems modelling approach. I did consider taking such an approach, and there may have even been the opportunity to do so when I first became involved in the idea of doing a masters project.

Shortly after I signed up for the challenge, I had a meeting with Professor Mark Swilling from the Sustainability Institute. He invited me join the Energy Working Group that was part of the IIC in Stellenbosch.

Briefly, the IIC was set up by the mayor of Stellenbosch as a way of promoting stakeholder engagement to manage some of the serious development challenges that Stellenbosch Municipality is currently grappling with (IIC 2014). Their aim is to use innovative strategies to address service delivery challenges they face, particularly with regards to waste management, water management, electricity and energy management, transport management, and infrastructure development (IIC 2014). The municipality would like to work towards being the greenest municipality that presides over a safe area that is attractive to various investors. These aims are laid out in greater detail in the Integrated Development Plan (IDP) for the greater Stellenbosch area. This is the spirit in which the municipality approached the Sustainability Institute for assistance in developing the Spatial Development Framework (SDF) for Stellenbosch (Stellenbosch Municipality 2014). This document aimed to integrate a Transport Oriented Development (TOD) design with innovative ways to transform the electricity, water and waste management systems of the town.

I thought that I had been invited to the Energy Working Group to participate in and provide relevant research to assist its exploration into how the municipality might be able to design a transition of the Stellenbosch electricity system from its current status to being integrated with the aims of the SDF. Once part of the group

(consisting of Professor Alan Brent, Karin Kritzinger and myself), however, I realised that it had a different set of aims, and it was unclear how these aims articulated with the broader aim for TOD. The two sets of aims were not only contradictory in some respects but also extremely different in others. From attending and observing a number of IIC meetings, it also became clear that there was a lack of enthusiasm for the meetings that were scheduled on Friday afternoons and, in some cases, a lack of cooperation or a passive resistance, amongst some stakeholders, to the whole process (Personal journal 2015). I realised that, while the idea of TOD and of promoting true transformation of the electricity system in Stellenbosch sounded fantastic, I realised that, perhaps, below the surface, all was not well and that making progress towards this level of transformation was unrealistic. I became weary of how to proceed.

Soon after the SDF was finalised and released, the IIC meetings were suspended indefinitely. At the time of writing (nearly a year later), there has been no more news on when they might resume. It clearly therefore was not the most appropriate timing for me to attempt a research project of this kind and this represented the main external barrier.

2. Increased interest in the stated aims of the Energy Working Group

I started by investigating the aims of the Energy Working Group. Among the aims listed in the Terms of Reference that the group sent to the IIC was the focus on the promotion of the uptake of SSEG systems amongst residents in Stellenbosch (Swilling 2014, personal communication, 6 October). One of the other aims was to generate research to support the request for the Stellenbosch Municipality to enable a FiT for residents wanting to sell their excess electricity back to the municipal grid. It was not clear why this should be a priority, however, as I was unable to find any policy or plan that required a FiT scheme in order to ensure more sustainable development of the Stellenbosch Municipality's electricity system. The questions about (i) where the call for SSEG originates and (ii) why such emphasis on SSEG

PV exists in South Africa, as opposed the exploration of the potential usefulness of any other form of DG system, emerged here.

I had sufficient resources (time, financial support and well connected supervisors) to conduct a case study into the uptake of SSEG PV and DG in the South African context. Once I had chosen my area of study, the current topic and research design then emerged over time as new information came to light and as my understanding of the issue under study deepened. The details of how my topic emerged are explained as part of the rationale (in the following section) because the topic and research question are closely related to missing information in the current discourse that could be useful to policy and decision makers on the issue of SSEG in South Africa.

3.The nature of the research:

This participative research approach using a case study that makes use of both quantitative and qualitative methodologies to design and gather data using a mix of research methods. Olsen (2004) highlights that while quantitative and qualitative research methods are often kept and taught strictly separately, there are many benefits to attempting to combine them. Unfortunately there is little practical guidance on how this can actually be done; however, this provides space and flexibility for researchers to design context specific combinations of methods – even though this may be more challenging.

Quantitative and qualitative research methodologies need not be considered and used in isolation from one another. Instead, triangulating findings from each (where both methods were employed in a single study) "...can get two or three viewpoints upon the things being studied. The resulting dialectic of learning thrives on the contrasts between what seems self-evident in interviews, what seems to underlie the lay discourses, what appears to be generally true in surveys, and what differences arise when comparing all these with official interpretations of the same thing"

(Olsen 2004: 6). I aim to gather both demographic data from participants as well as qualitative data from a focus group discussion amongst participants. I also aim to include a questionnaire to gain insight into participants responses to questions, particularly those related to whether or not participants would consider investing in SSEG PV technology on an individual level because they may not want to discuss this potentially sensitive information publicly.

I therefore take a reflexive, mixed methods approach to this research in an effort to combine information gathered from a number of different sources and to allow my learning process to shape the research. This approach also allows me to build a more holistic picture of the context under study as well as to provide enough detail on the specific areas of enquiry. I use the concept of triangulation as a tool or framework of analysis for my diverse data set in an effort to construct an answer to the research questions mentioned above. Jick (1979) explains that while triangulation is a useful tool to assess and ensure validity of results from mixed methods research, an idea supported by Modell (2005), researchers are also able to take a more **positivist and creative approach** towards the use of triangulation. Using triangulation creatively can be more useful in practical situations where research is done to contribute to current debates or developing better, holistic understandings of current problems (Jick 1979: 610).

ii. The structure of the research design

I have provided a rationale for why mixed methods research and triangulation (informed by complexity theory, systems thinking and sustainability literature) emerged as the chosen research approach. In practice, this will work as follows:

First, I conduct a desktop literature review to determine how relevant stakeholders in other countries have justified and negotiated the opportunities and challenges presented by DG exploration and implementation. This includes several short case

studies for how some other countries have negotiated the complexities around SSEG PV as well.

Second, I zoom in on the opportunities and issues that emerge around SSEG PV in Stellenbosch Municipality and elsewhere in the Western Cape, by conducting a case study. The case study includes a brief desktop review of relevant literature and other research that has been conducted in the area, three interviews conducted with three government representatives (one each from the Stellenbosch and CCT Municipalities and one from the provincial level Energy Game Changer project) and one focus group conducted with a group of ten participants – homeowners from a wealthy residential area in Stellenbosch.

The case study represents a way for me to explore, in detail, the idea of focusing on the promotion of embedded PV systems at the residential scale in the South African context. I have chosen to focus on the one case in order to gain deeper insight and allow the voice of the residents and potential consumers to be heard in Stellenbosch. I have chosen to structure the case study in a way that includes both quantitative and qualitative data gathering techniques.

My reflexive research process also revealed that it may be worthwhile to compare the approach to DG in South Africa (the focus on the uptake of residential scale PV systems) to approaches taken elsewhere in the world in order to evaluate the effectiveness of the South African approach, given global, national and (importantly) local aims and needs.

A visual representation of the research design is provided below. A full critique and justification of the methodology and methods used is provided in chapter 2 of this paper.

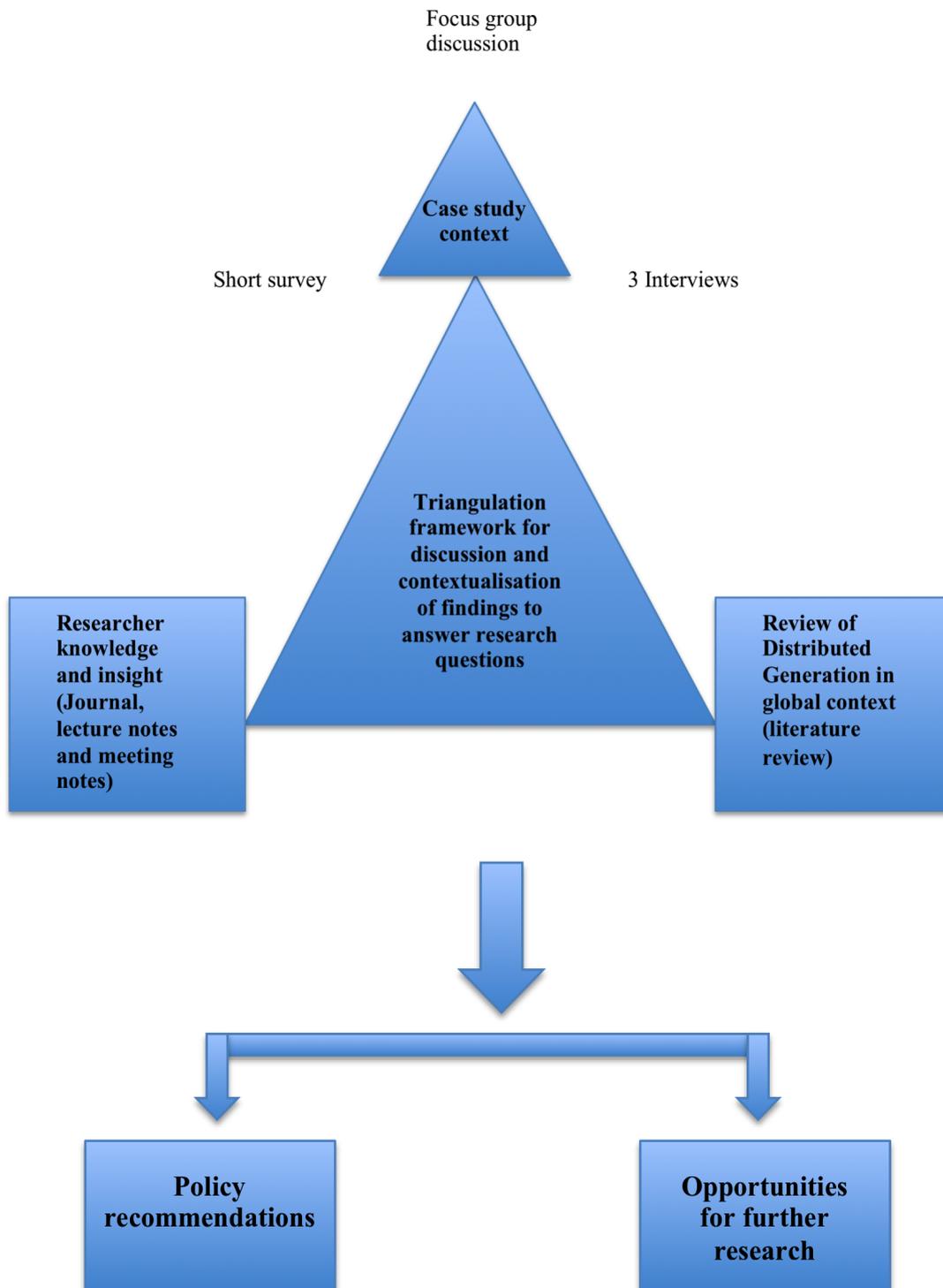


Figure 6: Diagram of research design for this study

f. Assumptions

The assumptions I have made are as follows:

1. Public consultation could yield some useful information that policy makers in Stellenbosch could use to improve efforts to facilitate the local uptake of embedded rooftop PV systems.
2. Local governments (municipalities) and other stakeholders are interested in knowing what consumers feel about the technology, and are willing to engage in a discussion about the implications of the results.

g. Rationale for the Study

This research is necessary and relevant for two main reasons. These reasons are explained in more detail below.

The primary reason for conducting this research is that there is only a limited amount of research in South Africa that aims to bring the voice of the consumer into the discourse around RE development, particularly in SSEG PV and DG development in South Africa. There is also a need for this type of insight that was expressed in the One World discussion and by both Mr. Coetzee and Ms. Cabral Wicht. This research gap is explained in more detail in Chapter 4. This study therefore aims to take the first, small step in introducing potential consumers' voices to the discourse around the uptake of SSEG PV in a very context specific case in Stellenbosch, South Africa, to determine what their response to the idea and to the FiT scheme is.

This insight could also prove useful to determine the extent to which the FiT structure introduced in Stellenbosch is aligned with national goals and commitments

to sustainable development and poverty alleviation. Emerging findings also have the potential to directing future research for policy development that is more in line with sustainable development goals.

I came to this conclusion after attending meetings and speaking to various stakeholders in the SSEG space in the country. In addition to having a number of meetings with my supervisors, Professor Alan Brent and Karin Kritzinger, these meetings included those with the Head of Electricity, Mr Jan Coetzee (on 19 May 2015 and on 1 December 2015); the Executive Director of Municipal Infrastructure and Services at the South African Local Government Association (SALGA), Jean de la Harpe and Aurelie Ferry, Renewable Energy Technical Advisor, also from SALGA (on 20 January 2016); Andries Holtzhausen from AW Power, a solar PV retail company based in Glencairne, Cape Town (on the 11 March 2016); Ms Cabral Wicht (on 10 June 2016) from the Energy Game Changer project; and the Head of Renewable Energy for CCT, Mr. Brian Jones (on 1 July 2016). I also attended a very useful round table discussion at One World (held on 6 April 2016) by a research group called Partners in Development.

The second main reason to conduct this research is because another area of interest that emerged from the meetings and discussions listed above, includes an exploration of how the Stellenbosch Municipality's approach to facilitating the uptake of rooftop PV compares to approaches that other countries (both developed and developing) are taking towards the exploration of DG and SSEG development. There is therefore an interest in this topic amongst stakeholders and policy makers that this research aims to satisfy.

In conclusion, this research is relevant for two main reasons. First, it aims to gain more insight into the aims and objectives behind the focus on the promotion of SSEG PV in South Africa, and determine whether or not these objectives are aligned with the goals for integrated development, increased uptake of renewable

energy systems, and sustainable development laid out in the National Development Plan (NDP) and Industrial Policy Action Plans 1 and 2 (Goga & Pegram 2014). Second, it aims to contribute some information to address the policy gap in South Africa with reference to the guidelines for the uptake of DG and SSEG PV at local level. Third, there is a lack of consumer and public engagement (let alone in-depth stakeholder interaction processes) that are included in the research that has informed the policy development (for the SSEG policies released by each of the few municipalities) to enable FiT schemes for embedded PV. Fourth, this research serves to satisfy my own interest in further exploring the idea of DG in South Africa and how this compares to how the idea has been explored in other parts of the world. This research therefore contributes to the limited body of research on public engagement on issues related to SSEG policy development in South Africa. This research also has the potential to provide many opportunities for future research that aims to follow a similar line of questioning, and shows the importance of this angle of research in generating information that can more effectively promote policy change and inform policy development for transitions towards a more sustainable, ethical and just future.

h. Chapter Outline

Chapter 1: Introduction and background

This section introduces the area of study and explains the journey of discovery that lead to the conceptualisation of the research topic. Background information explaining the context of the electricity sector and its structure is provided. The problem under investigation is briefly discussed before the aims and objectives of the study are explained. This is followed by a description of the methodology that will be used to fulfil the research aims and objectives, and finally the rationale for the study is provided.

Chapter 2: Methodology

This study aims to use triangulation as the overall methodology and the reasons for this are explained in detail. The various methods of data collection that will be used are then similarly explained. These include a case study consisting of several individual interviews and a focus group with a group of Stellenbosch homeowners, set up to discuss their opinions regarding the policy change that will enable them to connect their solar PV systems to the grid and sell electricity back to the municipality.

Chapter 3: Literature review: DG

This chapter explores the concept of DG in more detail in terms of what it is and what the advantages and disadvantages of these models of energy generation are. I briefly review 17 cases in 17 different countries that have explored the implementation of these systems. These are then evaluated in terms of the strategies that were used to implement the systems and the extent to which they were considered successful by the authors of each respective study. These strategies are also evaluated in terms of the context for which they were designed and applied to reveal the similarities, if any, which may exist among the recommendations for improvement, wherever provided. Similarities do emerge, as does a more holistic approach (provided by Odarno et al 2015) that addresses each of the similarities in a more holistic way and I suggest could be used in future attempts to implementing DG systems in general.

Chapter 4: South African context and case study

This chapter deals with the concept of SSEG PV in South Africa in more detail with specific reference to the context of the Stellenbosch case study, broadly located in the Western Cape. The case study is then used to examine the attempts, made by

various stakeholders, to promote the uptake of residential scale PV systems more closely and to determine the reasons for, and the effectiveness of, this strategy to implement SSEG in the absence of guiding policies. First, the context of the case is described in detail before the findings that emerged from the focus group and interviews are presented and discussed. The need for and importance of public consultation in this process is also emphasised.

Chapter 5: Analysis of results: triangulation of findings

This chapter provides a more detailed explanation of the perspective of sustainable development and complexity theory from which I interrogate the focus on the uptake of SSEG PV in the case study context. A further analysis of results of the focus group discussion with the residents and from the interviews is made by triangulating these findings with those from the literature review as well as with the perspective explained, to determine the extent to which the tendency to focus on SSEG PV uptake is useful to promote the development of a more sustainable future in the electricity sector in the Stellenbosch Municipality and Western Cape.

Chapter 6: Recommendations and Conclusion

The analysis of the results reveals several key areas for future research, which are explained in more detail in this section. The insights gained from the process of triangulating and analysing these three different sources of information are useful to policy and decision makers for a number of reasons. All my suggestions are put forward in this section before the research paper is concluded.

2. Chapter 2 – Methodology and methods

a. Introduction

Designing this research was a challenging process. This is because, apart from having very limited experience in the field of RE, I also began this project with only a basic understanding of the discourse on the issues around the uptake of SSEG PV in South Africa and only a vague idea that there was more to the concept of DG than SSEG PV. As a result, I was initially advised that the key challenge was to find out what the response from residents would be if the municipality were to enable a feed in tariff (FiT) so that they (the residents) could sell any excess electricity they generate from their solar PV systems back to the grid; and that this could possibly be done by designing a survey and gathering responses from as many homeowners as possible. I have already explained some reasons for why I eventually abandoned this line of inquiry in favour of the current research design in chapter 1 however, here, I explain how the initial research design (the survey) led me to notice some interesting points that ultimately caused me to conduct a more in-depth investigation than simply developing a survey. This is explained below, before I explain the current research methodology and methods in more detail.

As depicted in the visual representation of the research design, this study makes use of mixed methods methodology and includes both quantitative and qualitative research methods that are all analysed with reference to the concepts of triangulation and emergence (borrowed from complexity theory). The research methods include a desktop literature review, the bulk of the research in the form of a case study (that includes a short survey administered to ten focus group participants, a transcribed focus group discussion with the same ten participants and three transcribed interviews with key policy and decision makers (directly and indirectly) relevant to the case study context), and reflections on the theoretical perspective offered by complexity theory, systems thinking and interpretations of sustainable development literature. First, the research methodology is explained and justified

before each method is discussed in the same way, with reference to its relevance to this research context.

b. Towards the development of the research topic

My initial research design had a rather rigid structure because I aimed to conduct a large survey that could allow me to measure the attitude (of Stellenbosch residents) towards the idea of investing in PV systems if they could sell excess electricity back to the grid. According to research I had done into both psychological and marketing theory on the measurement of attitude and its influence on behaviour (Shove 2010; Azjen & Madden 1986; Ozaki 2011), this was technically possible to some extent, however, a range of external factors arose, and it became clear that, while this may have provided a set of more demographically representative data, the data from the survey itself was unlikely to provide the answers to the research questions. This is because the research question focuses on how residents would respond to an attempt to include them in a discussion that aims to gather information that could inform a policy and decision making process, what they may have to contribute, and on how their feedback on a decision could be useful to decision makers. It is not simply an attempt to uncover what participants think about SSEG PV but rather to gather more information on whether or not residents in Stellenbosch would participate in the opportunity to feed excess electricity back into the grid and, if not, to question the usefulness of the policy itself.

A key article relevant to the South African context provides evidence for the existence of the assumptions that I began to question. This article, commissioned by Green Cape and conducted by the Centre for Renewable and Sustainable Energy Studies (CRSES) at Stellenbosch University, aims to provide unbiased information to stakeholders and policy makers on the current state of the rooftop PV market in South Africa and provides suggestions for how this market can be unlocked. This article is useful in the sense that it is concise and provides an overview of the policy space for RE in South Africa as well as how the policies *could* apply or can be

considered relevant to the uptake of rooftop solar PV systems. The assumptions made in this article include:

1. There is a demand for residential scale rooftop PV systems amongst homeowners in South Africa (and possibly also in Stellenbosch) and that “...the main motivation for potential owners of rooftop PV systems is considered to be financial” (Reinecke et al 2013: i). The extent of the uptake, should a FiT be enabled, is unknown. Municipalities would like to have an idea of how residents would respond in order to design the tariff structure and preserve revenue streams (Jan Coetzee 2015).
2. “...Rooftop PV is aligned with and supported in principle throughout the government decision making process” (Reinecke et al 2013: 7).

Another article on the current state of the South African electricity situation by Steve Heddon (2015) echoes the seemingly popular notion that there is a growing demand for rooftop PV systems in South Africa because these systems cater for a variety of specific, and increasing needs:

“Independent power producers (IPPs) are contributing to electricity supply, and embedded generation – largely in the form of residential PV, which is playing an increasingly important role in decreasing demand on the national grid” (Hedden 2015: 1)

The suggested advantages of rooftop PV, listed in Reinecke et al (2013: 3), are quoted below:

- Climate change mitigation (and other environmental benefits)
- Job creation (and other socio-economic benefits)
- Security of electricity supply (through diversification and decentralisation)
- Potential for reduced electricity costs (short term and/or long term)

- Local ownership of generating capacity
- Peak load shaving
- Stimulating local economy
- Fostering technological innovation
- Mitigate electricity supply bottlenecks
- Favourable investment opportunity

Reinecke et al (2013: 3) also acknowledge, however, that these are potential benefits that apply to the promotion of the uptake of RE systems in general and not specifically for the implementation of rooftop PV systems. Nor do they present a strategy for **how** these potential benefits can be achieved, measured and included as targets in policies.

I noticed this, as well as the way the researchers had placed these potential benefits alongside a set of policy commitments made by the South African government for the facilitation of the uptake of RE systems in general (again, with no specific mention of commitments to facilitate the uptake of rooftop PV systems) with the aim to “...clearly show that rooftop PV is aligned with and supported in principle throughout the government decision making process...” (Reinecke et al 2013: 7). I realised that some of the assumptions that my initial research question relied upon may need some revision because the researchers have not specifically shown evidence of direct support of embedded rooftop PV by the government nor have they clearly shown the direct benefits of SSEG to managing the electricity-related crises (explained in chapter 1) in South Africa or the environment (by clearly presenting a plan for the reduction of GHG emissions).

I began questioning the extent to which the uptake of rooftop PV systems could lead to the realisation of some of the benefits listed above, such as “climate change mitigation” and “security of electricity supply (through diversification and decentralisation)” in the absence of any such structured plan or strategy (Reinecke et al 2013: 3).

I also questioned the extent to which the investment into rooftop PV systems was perceived as being “favourable,” given that many residents I had casually spoken to seemed unclear about how the technology worked, let alone how it could be considered a favourable investment (Reinecke et al 2013: 3). The extent to which the voice of the consumer, in terms of their opinions on their idea of investing in PV had actually been captured and considered, seemed to me to need more investigation as well. This is because preliminary searches for studies in South Africa that had actually aimed to capture this voice came up blank. There is therefore a gap in the research that needs to be filled, because in its absence there is space for decisions to be made that are based on assumptions and not necessarily on academic research.

I realised that, by attempting to focus on designing one survey, I was attempting to take an objectivist, quantitative approach towards answering a question that would best be answered with qualitative data and a subjective approach (Bryman et al 2014). As a result, I went back to the drawing board and decided to design a research methodology that allowed for a more reflexive, inductive research process and that allowed me to gather qualitative feedback and let the voices of the participants come through.

This new approach includes data gathered using a number of different methods that I have analysed using a framework of triangulation as first described by Todd D. Jick (1979). Jick (1979) points out that triangulation “... can be something other than scaling, reliability, and convergent validation. It can also capture a more complete, holistic and contextual portrayal of the units under study...” (Jick 1979). This is the way I intend to use the concept of triangulation. I have gathered qualitative and quantitative information from:

1. A case study: including a focus group, a survey and three semi-structured interviews.

The focus group discussion included ten residents from Stellenbosch, who participated on a voluntary basis, and the short survey. The survey was administered in two parts and was completed by those same participants. The first part of the survey (part one) was completed in the beginning, before the focus group information dissemination and discussion sessions began, and the second part (part two) was administered after the information dissemination and discussion sessions, just before the end of the focus group.

In addition, qualitative data from three semi-structured interviews with members of both the Stellenbosch and CCT Municipalities was gathered to gain insight into the perspectives of other stakeholders within the scope of the case study. These were with Mr. Brian Jones, Head of Green Energy at the CCT, Ms Cabral Wicht, Head of the Energy Game Changer Project in the Western Cape, and Mr Jan Coetzee, Head of Electricity at Stellenbosch Municipality.

2. A desktop study: DG in the global context.

This section reviews the existing literature on DG (including SSEG) systems that have been discussed and implemented elsewhere in the world. I have gathered and presented a collection of 17 short case studies on these approaches. Each case study includes a brief description of the context in which the DG system was applied, the circumstances surrounding its design and application (including the need it was designed to meet, how that need was identified, and the extent to which public participation was included involved in its design and implementation processes. I take note of what challenges arose for each case and how these challenges were managed as well as whether or not the project is perceived as being a success or failure. Where relevant, I briefly compare the case context to the South African

context and approach to DG to see if there are any similarities or differences, as well as to evaluate whether any of these approaches could be adapted or are relevant to the South African context.

3. Researcher observations, knowledge and insights

Throughout this research process I have attended a number of meetings and engaged in a number of discussions, both formal and informal, on the topic of embedded rooftop PV and on the idea of alternative DG options for South Africa. I have recorded the insights I gained from these in a journal that I have kept and that I reference to show how these have influenced the research process. I have also gained much theory and knowledge about the complexities of sustainable development from my experiences at the Sustainability Institute that I have used to guide my investigation.

c. A Case Study Approach with Mixed Methods

Olsen (2004) highlights that, while quantitative and qualitative research methods are often kept and taught strictly separately, there are many benefits to attempting to combine them. Unfortunately there is little practical guidance on how this can actually be done; however, this provides space and flexibility for researchers to design context specific combinations of methods – even though this may be more challenging.

Quantitative and qualitative research methodologies need not be considered and used in isolation from one another. Instead, triangulating findings from each (where both methods were employed in a single study) "...can get two or three viewpoints upon the things being studied. The resulting dialectic of learning thrives on the contrasts between what seems self-evident in interviews, what seems to underlie the

lay discourses, what appears to be generally true in surveys, and what differences arise when comparing all these with official interpretations of the same thing" (Olsen 2004: 6).

I aim to use a triangulation of data gathered from a mix between quantitative and qualitative research methods to determine two things:

1. I aim to use the survey to determine whether or not the results would reflect the conclusions drawn in the focus group discussion. This is because, while people tend to express certain feelings in a group scenario, their personal opinions may differ, and participants answering individual questionnaires may more likely express these privately..
2. Parts one and two of the survey will be administered separately as explained above. Both these surveys contain similar questions and this is done to determine whether participants' answers to these similar questions may be different before and after the information dissemination and discussion sessions. If these answers differ, it could indicate that the spread of knowledge can affect participants' responses to the FiT scheme and could prompt further research into how to design information campaigns to increase the chances of obtaining the desired effect.

While Olsen (2004) notes that combining and analysing mixed methods data is a challenging process, the challenges are mitigated by the fact that this methodology allows for greater flexibility and provides more space for the emergence of nuanced findings.

The results from all three data gathering methods (desktop study, interviews, and focus group material) are triangulated as explained in chapter 1, in the research design section. "Triangulation means mixing approaches to get two or three viewpoints upon the things being studied. The resulting dialectic of learning thrives

on the contrasts between what seems self-evident in interviews, what seems to underlie the lay discourses, what appears to be generally true in surveys, and what differences arise when comparing all these with official interpretations of the same thing” (Olsen 2004: 4). Because I have coupled this with the concept of *emergence*, borrowed from complexity theory literature, I apply the concept of triangulation fairly loosely and instead allow the emerging findings to reveal their own analytical structure. I use thematic analysis methods to interpret the findings from the qualitative data gathered in the focus groups and interviews, and simple data handling methods to analyse the findings gathered from the surveys. Each of these methods and the tools for analysis used are all now explained in more detail.

i. Desktop literature review

The aim of doing this literature review is to look for information on the different ways in which DG and SSEG PV projects have been managed abroad. I wanted to look at what factors make some projects more effective than others. In my initial literature searches I had recognised the recurrence of similar themes, opportunities for future research, and of improvements that could have been made to different DG projects and approaches that were highlighted by various authors. The literature review is also a way for me to determine where any gaps in the research exist and how this study could contribute to the current discussion on DG and SSEG PV in South Africa.

I began my search by typing the following key words and phrases into Google Search and Google Scholar:

- “Distributed generation systems”
- “Embedded solar PV systems”
- “Embedded generation challenges”
- “Solar PV market”
- “Global S.S.E.G.”

- “Smart grids and distributed generation”
- “Micro-grids”
- “Public consultation and distributed generation”
- “Feed in tariff solar PV”
- “Embedded generation examples”
- “S.A. Solar PV uptake”
- “Countries with centralised electricity systems”
- “Solar market in South Africa”
- “Demand for green electricity”

These searches led me to a large number of articles because the idea of DG was one that emerged as early as the 1970s.

I was advised to prioritise those published in 2010 and after because this is an extremely dynamic discourse on a topical issue in South Africa and elsewhere to research, and, even at the time of writing, new pieces were published as the discussion progressed. As I read through these articles, I discovered other articles that were mentioned and I searched for them specifically on the Stellenbosch University Library website . The bulk of the articles I have consulted come from journals such as Policy, Renewable and Sustainable Energy Reviews, Energy for Sustainable Development, Electric Power Systems Research, Applied Energy, Progress in Photovoltaics: Research and Applications, Electricity Journal, Renewable Energy, Environmental Research Letters, Economic and Political Weekly, and Energy Conversion and Management.

I have also included grey literature in the form of policies, acts, and reports from various key organisations and NGOs with influence in the RE space in South Africa and abroad. These include the World Resource Institute, World Wildlife Fund (WWF), Green Cape, Stellenbosch Municipality, and CCT Municipality.

The literature can be divided into two main categories: articles that deal with small-scale DG projects in general, and those that specifically deal with the uptake of embedded generation from solar PV systems (in the residential and commercial sectors). I decided to ignore articles dealing with large/utility scale embedded generation systems because there is already a specific policy legislation that deals with the uptake of these in South Africa that has been quite effective. I also noticed a second criterion that defined these two categories: most of the articles that dealt with the implementation of various small-scale distribution projects were done in developing countries (China, India, Kenya, Tanzania and Zambia), and those articles that dealt with the various mechanisms for facilitating the uptake of small-scale solar PV systems were from developed countries (the UK, Italy, the USA). Because South Africa is unique in the sense that it is, in many ways, a mix between the developed and developing worlds, I therefore expanded my search to include countries with similar contexts.

The literature was analysed according to three lines of questioning:

1. *What drives the uptake of DG systems in different countries and how are DG technologies selected?* (In order to gain general information on each DG case)
2. *How were projects designed and implemented? What enabling mechanisms were suggested and how were they implemented?*
3. *To what extent are these projects considered to be successful?*

The next section of the literature search was on the national policies regarding RE in South Africa. I went in search of evidence of a plan for the uptake of residential solar PV systems. This body of literature is used to outline the context within which the case study findings emerged and is not included in the literature review section.

The policies that I identified as relevant and consulted were ones mentioned in the various articles I found on the various aspects of RE generation in South Africa. These included:

- The National Environmental Management Act no. 107 of 1998
- The National Development Plan of 2011
- The Integrated Resource Plan 2010-2030
- The White Paper on Renewable Energy 2003
- Industrial Policy Action Plan

And the following acts:

- Amended Electricity Regulation Act 2006
- Electricity Regulations on New Generation Capacity 2010
- The local Government Municipal Systems Act no. 32 of 2000
- Public and Municipal Finance Management Act 2003

While these policies indicate that South Africa officially values and supports efforts to integrate future development paths in ways that ensure (among other things) a decrease in carbon emissions, an alleviation of poverty, the mitigation of climate change, and the growth of the economy, the development and implementation of a roadmap for the achievement of these ideals is limited. I do not provide a full overview of these policies as this can be found elsewhere (Winkler 2005; Winkler et al 2006; Pegels 2010) but I do use them to discuss the way in which they can be useful to this discussion.

This method was chosen to satisfy this avenue of enquiry because it is the most efficient way of gathering this type of information. Travel to each destination would have been well beyond the budget and impossible given the time constraints. The drawback is I have to rely on what other authors have written about them and have tried as far as possible to recognise and note any biases that emerge.

ii. Case study and method

What is a case study?

Using the case study method is widely acknowledged to be a challenging process (Baxter & Jack 2008; Yin 2009; Blaikie 2010). There is no consensus as to the definition of what ‘case studies’ actually are, leaving much room for interpretation and criticism of the method, particularly from modern, reductionist, scientific perspectives (Flyvberg 2006).

Jack Levy (2008: 2) defines a case study as “...an attempt to understand a spatially and temporarily bounded set of events.” Robert Yin (2009: 45) provides a better definition by explaining that a case study is an “...inquiry that investigates a contemporary phenomenon in depth and within its real life context, especially when boundaries between phenomenon and context are not clear.” He also recognises a second part to the definition that relates to the methodology of a case study, and explains that case study research design includes the use of multiple research methods as well as the use of triangulation or similar method for analysing and discussing findings (Yin 2009). Yin’s (2009) definition of a case study strongly resonated with the kind of research that I wanted to conduct.

Yin (2009) explains that case study research is most useful for improving the understanding of a problem, and using this more detailed understanding to make recommendations as to how it may be managed. This is the primary reason for why I chose case study research: I aimed to promote an interaction between policy and decision makers and residents to uncover different perspectives on the issue of SSEG PV uptake in Stellenbosch and how this information may be useful in terms of making recommendations to policy and decision makers..

Purpose of the case study:

Case study research design is flexible and allows space to design a project that would allow me to engage with a real life issue and, as Baxter and Jack (2008) explain, to engage with the complexity of the context to a certain extent.. By using this method, I was able to include data generated from a variety of data sources, both qualitative and quantitative and to include the voices from a number of different influential actors in the space. These actors included:

- Engineers from the electricity departments in Stellenbosch Municipality as well as those from the CCT Municipality;
- Actors from a provincial level project operating from the Office of the Premier promoting the uptake of green energy: 100% Green;
- Members from another provincial level, NGO called Green Cape; and
- Stakeholders on the ground: a sample of residents from Stellenbosch.

The use of the case study method also enabled me to allow findings to emerge and to include complexity theory in the design (of the study itself) and in the analysis of the findings. This explanation is provided in chapter 5.

Scope and method

The scope of the case study itself is limited to the specific investigation into what the group of residents who participated in the focus group had to say about embedded PV technology and the extent to which the proposition of a FiT would motivate the uptake of these systems. The case study method, however, requires the provision of context for this investigation, and that extends to a brief discussion of the state of RE in South Africa (in terms of the relevant policies and policy gaps) as

well as a more detailed discussion of how the uptake of DG (specifically SSEG PV) is managed in the Western Cape. This more detailed discussion is supplemented with information gained from a number of meetings I attended with various stakeholders and policy makers. The aim is to provide a broad description of the context from which the responses and opinions of the sample group to the release of the FiT in Stellenbosch emerged.

I used various methods to gather the different kinds of data I needed to understand, analyse and describe the various aspects of the context for the issue under study because I could use each method to explore a different sub-question. This provided insight into various aspects of the contemporary issue under study – the motivation for, and the response to, the policy change enabling the release of FiTs for residential embedded generation in Stellenbosch. I used three main data collection methods: a focus group, a survey, and individual interviews held with various policy makers.

The critique and justification of the single case study method is provided after each of the components of this particular case study has been discussed.

Focus Group

This served as my primary focus area of the case study. I have already discussed the policy gap where residential scale embedded solar PV generation is concerned, and I argue for the importance of social engagement and consumer consultation in attempts to find more effective ways of implementing DG projects. The aim of the focus group is to conduct one of the first consultations with relevant residents in Stellenbosch, to explore their responses (recorded and transcribed), and see what insights can be gained from a thematic analysis of the results.

a) Purpose

The focus group discussion is held with a sample of ten homeowners in Stellenbosch for whom the policy change is relevant. It was designed to gather information to answer the following main question:

What are participants' opinions (in their capacity as homeowners in Stellenbosch) on the policy change that suggests a feed in tariff to enable them to invest in and use their small-scale solar PV systems to become embedded generators?

b) Sampling method

I used non-probability sampling methods as my sample of participants for the focus group was a convenience sample (Bryman et al 2014). Transparency in this regard is provided to mitigate the effects of bias and to promote the construct validity of the study.

I opted for the convenience sample method because the target group of participants included those specifically considered wealthy enough for the financial costs involved in the investment in an embedded solar PV generation system. This was done in an attempt to remove the topic of the financial barriers to the uptake of solar PV systems (already acknowledged to a great extent) and to create space for other opinions, feedback and topics of discussion to emerge.

In order to gather participants, I took advantage of the connections that my co-supervisor, Professor Alan Brent, had in the Stellenbosch community. He assisted by sending an invitation to the Jonkershoek Rating Association (JRA) (of which he is also a member). The membership includes homeowners from all the middle-upper income suburbs to the east of the town, as well as from the Jonkershoek Valley. The valley also forms part of the Stellenbosch municipal area. The participants then self-

selected and the first ten to respond to the invitation were included. I made the assumption that those who responded had some kind of interest in the issue, but recognise that I cannot assume that those who did not had reasons related to a lack of interest.

Many of the participants knew each other already, which made for a good, relaxed environment where they felt they could share their thoughts and opinions freely. This made for an interesting and lively discussion. I acknowledge the existence of self selection bias and do not claim that my findings are generalisable to the broader population. The time and place of the focus group was designed to make attendance easy for the target group of participants (by scheduling the discussion to take place on a weekday evening after work at a central location in Stellenbosch) but I acknowledge that it may also have made it inaccessible to others. This can be addressed by a future study as my aim is to generate interesting, in depth findings that can highlight opportunities for future research. Further research would, for example, be needed to determine why others did not respond and whether their reasons are relevant to the present discussion.

A disadvantage of including people who know each other is that any pre-existing patterns of communication or feelings may surface in the focus group discussion in ways that I would not be aware of (Bryman et al 2014). Groups who are familiar with one another may also interact based on a shared (or assumed to be shared) set of values, opinions or assumptions that would not necessarily be openly pointed out in the discussion. Even though these are legitimate concerns, I chose to use a “natural grouping” of participants as I was more interested in gaining some insight into the collective opinions and thoughts of homeowners in this area of Stellenbosch towards the policy change if possible (Bryman et al 2014: 235).

Azjen and Fishbein (1977), authors in the field of psychology, discussed the idea of the influence of subjective norms on attitude formation and the possible links this has to behaviour. In a more recent study, Azjen and Cote (2010: 302) identify the

importance of uncovering subjective norms (perceptions people have of social pressure that determines group ideas about what is important and what generally should or should not be done) when attempting to understand, at least in part, aspects of people's attitudes and behaviour toward certain things/events/situations. While I have come to the conclusion that predicting human behaviour to any degree of accuracy is not strictly possible, given the nature of people, I still believe that uncovering group beliefs and dynamics may be useful to assist the design and implementation of RE or energy efficient interventions in their communities. This is because, as Brent (2014) has shown, this is an important way of strengthening the sustainability of the initiative. I am therefore interested in how they create and share ideas for what the policy change could mean for them and how, based on these understandings, they may respond.

c) Focus group structure

The focus group was held on the fourth floor of the Knowledge Centre at the University of Stellenbosch in the main boardroom of the Centre for Renewable and Sustainable Energy Studies at 17:00 on 21st June 2016. A reminder was sent to the JRA via *Whatsapp* message a week after the invitation was sent. Participants were given two weeks in total to respond. They were also told that refreshments would be provided and that they needed to commit two hours of their time on the evening for the discussion.

Nine of the ten participants arrived on time and the tenth one arrived shortly after the information dissemination session had begun. Participants were welcomed, offered refreshments, and then asked to fill in the ethics clearance forms. The agenda of the focus group was explained and the researcher was introduced before participants were informed that the session was being videoed using the webcam in the room. I connected my laptop to the webcam and videoed the proceedings using a programme called *Photobooth*. Participants were assured that they would remain anonymous and that the data would be stored in a secure location on completion of

the project. A copy of the research would be made available to them once complete if they were interested in reading it.

Participants were then asked to complete a questionnaire on demographics and a survey (Part One). This was to gather some insight into their views on RE, solar PV technology investments, and the idea of becoming embedded generators. The facilitator then conducted a slide show presentation (see Addendum) to ensure that all participants understood the details of the topic at hand and were equipped to participate in the following discussion. Following the presentation, a semi-structured discussion was held, guided by ten open-ended discussion questions that I selected. I opted for a slightly more structured approach because I could not assume that everyone had the same level of knowledge on the topic even after the presentation (Bryman et al 2014: 235). Following the focus group discussion, participants were asked to complete a second survey (Part Two) that asked similar questions to the first survey as well as more direct investment questions than did the first questionnaire. This was to determine whether the information session and the discussion session had any effect on their thoughts and opinions and whether this effect led to any changes.

d) Facilitator choice and participant demographics

The discussion was facilitated by Professor Alan Brent, a respected resident member (and homeowner) of the community from which the sample was drawn. While he is a member of the Centre for Renewable and Sustainable Energy Studies and head of Engineering at Stellenbosch University, he is also an experienced facilitator and ensured that participants understood that he was addressing them in the capacity of a fellow neighbour and homeowner in Stellenbosch. I considered his knowledge in the field to be a useful resource for participants, should they have any questions. A lack of sufficient funding and time resources limited my options for hiring another, more independent facilitator, and I felt that, given the nature of some of the investment and financial questions that would be asked, having a complete

stranger in the room could have served to make some participants feel uncomfortable, whereas having someone who was familiar and in a similar situation as they were could inspire confidence and freedom of expression.

For the sake of transparency, I must mention that Professor Brent also co-supervised this project and was genuinely interested to hear what participants' responses would be. Due to his relaxed approach, however, I was, to a large extent, left with the freedom to design and conduct this research. I am grateful that he did not try to control and direct the process towards any predetermined outcomes. I had met several times with both my supervisors beforehand in order to discuss and agree upon the way the focus group would be handled. As agreed, Professor Brent took a very neutral stance in the actual focus group discussion, keeping his input to a minimum. I, as the researcher, designed and put together the information that he then presented to the participants, and took on the role as observer. I was present in the room for the duration of the discussion.

There is therefore little to say on the subject of how Professor Brent may have influenced the outcome of the discussion except to say that he did know some of the participants prior to the discussion. The negative effects of this familiarity, if any, were not evident as conversation flowed smoothly.

The focus group was held in English. I made the request for my convenience because my Afrikaans is not sufficiently proficient to keep up with a discussion of this nature and time constraints did not allow for the inclusion of a translator. I do recognise, however, that, given that the majority of Stellenbosch residents from this demographic prefer to speak in Afrikaans, my request may have limited the discussion in some ways. The request was met with a murmur and some laughter, which I took to mean that on the whole, everyone understood and did not have a serious problem with it. I should also mention that all participants were able to speak fluent English and no one was deliberately left out of the discussion.

The majority of participants who responded were white males roughly between the ages of 40 and 70 years old. There was one woman present and the only other two women in the room were my self and my supervisor, Karin Kritzinger.

e) Critique and justification

An advantage of using the focus group method is that it enabled me to gather more open-ended responses from participants. This was important because my initial attempts at designing a survey to answer this question proved unsuccessful. Using a survey only, although problematic, may have provided me with an idea of what people may have thought regarding the topic and line of inquiry; however, I would not have had the opportunity to gain insights into *why* they held a particular set of views, nor how those views presented themselves collectively.

There are also disadvantages to using the focus group method, particularly if only one of these discussions is held. The first limitation is that the results from this specific case study are limited to this context and results from this focus group discussion cannot necessarily be generalised to other contexts (Bryman et al 2014). I do not attempt to generalise my findings to the wider community but rather emphasise that this research serves to scratch the surface of the line of inquiry that can bring greater consumer and public consultation and input to a discussion largely dominated by technical, finance and policy related topics in South Africa.

This is important because policies, technology and financial mechanisms are designed for implementation in **social systems** involving individual consumers and communities of consumers whose reactions and behaviour cannot be accurately predicted or strictly controlled. Being aware of these factors and of the human element of these socio-political and economic systems for which technologies are created is vital to the success and sustainability of their uptake, and these are sometimes used with reference to the term socio-technical systems (Musango & Brent 2011; Wolsink 2012; Schäfer et al 2011).

Another disadvantage of the use of focus groups is that they are time and resource consuming (Bryman et al 2014). Data was gathered in the form of a recorded focus group discussion that was later transcribed and analysed by thematic analysis. This was also time-consuming and the benefits of deciding to hold only one focus group were soon realised and appreciated. Time constraints were also a significant concern.

The lack of adequate community representation in this research, I believe, is where my research is the most flawed, but as a masters student I could only do what was possible in the given amount of time. I also consider this aspect of my research to represent the greatest opportunity for future research that could include a more rigorous exploration into various subsections of public opinion (by race, age, gender, household income group and so on) on approaches for the uptake of RE systems or energy efficiency initiatives.

I have provided examples of my focus group material including discussion questions, short surveys and power point presentation in the addendum should any future researcher wish to replicate what I have done with another group. This focus group structure is therefore replicable to groups from similar socio-economic backgrounds, but some questions will have to be adjusted should the researcher wish to engage with a wider demographic.

The Survey/Self Completion Questionnaire

A survey or questionnaire is a more structured research method that enables the collection of quantitative, and demographic data. I have used a combination of both multiple choice questions and questions that require short, written answers (Bryman et al 2014).

In order to avoid asking people to share information of a sensitive nature in a group environment, I decided to include two short surveys to gather this information. The

demographic information included questions to gain insight into socio-economic status to determine whether or not each participant considered himself or herself as being capable of, and interested in, investing in an embedded solar PV generation system.

a) Purpose

This method was used to gather data to answer the following question:

Does the provision of more information on the feed in tariff, the policy, as well as its implications for homeowners wanting to become embedded generators, affect the participants' thoughts about whether they would like to invest in these systems? If so, how?

b) Structure

Two short surveys were administered, as part of the focus group, to the same participants. The first survey was split into two sections: the first section was aimed at gathering demographic information from the participants, and the second section at gathering some information about what the participants initially knew and thought about the electricity challenges in South Africa, RE and PV technology, and the idea of being able to install SSEG PV systems and become embedded generators. A brief explanation of what was meant by a 'solar photovoltaic system' and 'embedded generation' were provided to assist participants in answering the survey in an informed manner.

The second survey was administered after the focus group information session and the following discussion on the details of the nature of embedded generation, the policy, and the FiT. This survey asked questions about whether or not, in light of insights gained from the preceding information dissemination and discussion

sessions, they would STILL be interested in investing (or not investing) in an embedded solar PV generation system and in becoming embedded generators.

c) Critique and justification

The advantages of this method include that the questionnaires were short and easy to answer, making it more convenient for participants (Bryman et al 2014). Participants were able to provide their own answers without being influenced by peers or an interviewer, and questions were phrased in the same way and in the same order for each participant, decreasing risks of interviewer variability (Bryman et al 2014).

One disadvantage of administering the questionnaire to determine information on investment behaviour is that I was unable to explore the reasons for these answers in the moment. I therefore decided to make the focus group part of the overall research design. I was present in the room while participants filled in the questionnaires and thus could clarify any misunderstandings pertaining to the survey but was unable to press respondents for more detailed written answers to some of the questions. In order to keep the survey (and the overall focus group) from being too tedious and running over the allotted two-hour session, I decided to keep the questionnaires short to allow more time for the discussion.

The questions asked in the survey may be considered more personal than those asked in the focus group discussion and thus participants may prefer to answer them privately. This is also done in an attempt to mitigate response bias where participants' answers may be influenced by others. The survey responses are also collected anonymously to avoid the influence of response bias, where participants may aim to "please" the researcher or give the "correct" answer. This is an issue because asking someone whether or not they would invest in solar energy for sustainable development has connotations of judgement. For example: a respondent may feel that they might be judged as a "bad" person for not having any inclination

towards investing in solar PV and without a more thorough discussion, other reasons that motivate their decision may be lost.

Interviews

a) Purpose

In order to provide a more detailed understanding of the approach from members of the local government, towards the uptake of embedded generation and the emphasis placed on the uptake of embedded, residential scale solar PV systems, I conducted three semi-structured interviews with three different policy makers. My semi-structured interviews were conducted with ten open-ended questions to guide the discussion. However, I aimed to let the conversation flow as freely as possible so questions were not necessarily asked in the order they were written down in (Bryman et al 2014). Each interviewee agreed to having the whole interview recorded on my mobile phone and I later transcribed these interviews. Participants were informed of their right to end the interview at any time and to mention when they were about to say something they would rather not be quoted on.

b) Selecting and contacting interviewees

The three interviewees selected were recommended to me by my supervisors as experts in the field and as key players in the policy SSEG PV space, particularly in the municipality context. The first interview was conducted with Mr. Johan Coetzee, Head of Electricity in the Stellenbosch Municipality. Mr. Coetzee has worked as head engineer of the Electricity department for many years and is seemingly in the ideal position to discuss alternative electricity generation and RE technology options for the town. The interview revealed that this is not necessarily the case, however, and findings and recommendations are presented in chapters 4 and 5.

The second was held with Ms Cabral Wicht, manager of the Western Cape Government's 110% Green Initiative. Including the voice from the Western Cape government is to show the official commitment to developing a green economy in the province, which involves fostering conditions for the expansion of the solar PV market.

The third was Mr Brian Jones, the Head of Green Energy at the CCT Municipality. I specifically chose to include a voice from the CCT Municipality because many other municipalities interested in enabling FiTs for embedded PV look to what this municipality has done as an example of how to manage embedded solar PV systems at the residential scale.

Once again I made use of my well-connected supervisors in order to arrange these meetings. On the whole, I felt that everyone was willing to speak to me and had a genuine interest in the topics and issues I raised, many of which represented the everyday challenges that were part of their work.

c) Critique and Justification

I settled for semi-structured interviews because to allowing space for digression from, and expansion of, the discussion topics. This method enabled me to gain deeper insight into what was being done in the Western Cape province and what the policy makers themselves thought about it. Each interview was structured around the individual interviewee and the type of insight they could potentially provide, given their work positions. I wanted to get to the bottom of *why* promoting the uptake of embedded solar PV systems has been the chosen route for SSEG, seemingly at the exclusion of any other options for an urban environment, in South Africa.

I acknowledge that the information gained from the interviewees is not representative of the organisations they work for, however, each is responsible for

engaging with, and managing the practical aspects of designing green, RE transitions at local, municipal level. I also acknowledge that each interviewee is also part of a wider network of people working to make the green energy transition (specifically the uptake of SSEG PV at residential scale) a reality and that this network involves those from the finance and other municipal departments as well as members from other NGOs. This is an opportunity for a future study that focuses on understanding the nature of interaction and communication between these actors and how this affects the way the transition is managed, however, this is beyond the scope of this study. This study aims to specifically experiment with a process of engagement between policy makers and relevant residents to determine how such interaction could be useful to policy makers and to identify opportunities for future research that could contribute to the way the RE and green energy transition is designed and managed.

All the semi-structured interviews therefore had this fundamental, similar theme, even though questions to each person varied. I knew I was on the right track with my line of questioning when, in my last interview, with Mr Brian Jones, he eventually asked me why there was such a belief in embedded solar PV technology. Here, he essentially, after a long discussion, repeating my own question back to me. This is significant because if the policy maker does not see the reasons for why a particular policy change is being made... what exactly is the reason for the change in policy in the first place?

I met each interviewee at their workplace and enjoyed the process of speaking to them immensely, but one of the challenges of this process is that it was very time consuming. The transcriptions and analyses were also time consuming and I had to limit myself to only three interviews.

I chose to use thematic analysis because I aim to compare the themes that emerge from the focus group to the themes that emerge in the interviews to see what

insights can be gained. These will be discussed in chapters 4 and 5, where I present, triangulate and discuss the results.

Thematic analysis is a tool to analyse qualitative data that can be done manually or using coding software such as Atlas-ti, NUDIST, Linguistic Inquiry and Word Count. While this software is advantageous because it enables researchers to quickly analyse large amounts of qualitative data, it is limited in that depth and nuance may be lost as software analysis tends to oversimplify the data (Firmin et al 2016). In this case, I had a manageable amount of data to conduct a manual thematic analysis. The process was as follows:

1. All recorded interviews as well as the focus group discussion were transcribed, verbatim.
2. I read through each transcript twice
3. On the third reading of each transcript I began making notes in the margins of similar points that emerged and were repeated, and of contrasting ideas and opinions. I also took note of information that could be useful to policy and decision makers.
4. From the margin notes, I isolated seven key themes that emerged:
 - What potential consumers of SSEG PV want from the technology and policy
 - What policy makers want from the increased uptake of SSEG PV
 - The technical and institutional capacity of municipalities to provide what is wanted
 - The inclusivity of the FiT policy- social considerations
 - Viability of SSEG PV (financial)
 - Environmental concerns and potential benefits of SSEG PV

- Scepticism around the ability of the policy to promote uptake of SSEG PV: how does this fit into long term plans for a green energy transition? Targets? Monitoring?

I then read through the transcripts again and highlighted quotes that fell under each theme in a different colour. In a notebook, I wrote the seven themes as headings, each on a separate page. Under each heading I wrote the collection of relevant quotes that support it. A structure for the write up emerged from this process and the findings are presented under the following headings (derived from the themes).

1. The differing perspectives on the problem;
2. A clash of objectives;
3. Consumer related feedback;
4. Ethical, environmental and social considerations; and
5. The role and effects of knowledge dissemination.

An analysis of these findings provided in chapter 5 illustrates how these findings are useful to better understand the case at hand, and how this understanding and information gained can be used to make policy and research recommendations.

Critique of selecting the single case study research method

There are a number of advantages and disadvantages attached to conducting a single case study. The advantages are that it was far less expensive and time consuming as compared to the costs that would have been involved in doing several (Blaikie 2010: 191). This method also allowed me to spend the time and resources I did have to exploring my question in more detail, and enabled me to share a number of voices from both the potential consumer and policy side of the scenario.

While single case studies tend to be criticised for “...lacking reliability and validity when compared to other research methods” (Pieters et al 2014: 60), Flyvberg (2006)

also points out the huge benefits of this type of method. The summary of these advantages provided by Pieter et al (2014: 60) are listed below:

1. “Context-dependent knowledge is **more valuable** than theoretical knowledge.”
2. “Formal generalisation is **overvalued** in research, while the individual example is **underestimated**”.

This argument is particularly relevant to this case study because each municipality in South Africa that is interested in engaging with the idea of enabling embedded generation is handling the relevant opportunities and limitations in a different way. This study also includes a very small, highly unrepresentative sample of participants. However, what they have to say is shown to be extremely valid. This research, however, does not aim to review all these approaches or claim to have results that are fully representative, but rather to fully describe and analyse the approach taken by the Stellenbosch Municipality towards enabling the uptake of SSEG PV, within the Western Cape context.

3. “The case study has **no greater bias toward verification** of the researcher's preconceived notions than other methods of inquiry.”

This is relevant to this study because in this case study, as in any other, the researcher may unintentionally allow their bias to colour the presentation of the narrative. In order to avoid this, I have kept a journal throughout the research process where I have noted my thoughts, reflections, frustrations and beliefs so that I am aware of them. I have tried as far as possible to include them in this write up in order to improve the transparency of the research. I will go into this in more detail in the next section.

4. “The case study is useful for both **generating and testing of hypotheses**.”

This is generally true for single case study research, however, less so for this study as I have decided to allow research findings to emerge rather than to begin with and test a hypothesis. This research is therefore more inductive than it is deductive (Bryman et al 2014).

5. **“Good case studies should be read as narratives** in their entirety, in order to understand the context of the case.”

This case study is also constructed as a narrative because participants’ responses are highly context specific and cannot be generalised given the racially, culturally and socio-economically diverse Stellenbosch population. In this case, the narrative begins with the Self Generation of Electricity and Feedback into the Stellenbosch Municipal Grid Policy (2015/2016) that was released by the Stellenbosch Municipality, progresses to uncover the focus group participants’ responses to the policy and, in light of information gained from the case study, comes full circle to question the usefulness of the policy itself- in terms of the extent to which it facilitates a sustainable, green energy transition at local level with the promotion of SSEG PV.

Now the disadvantages are discussed, followed by a brief discussion of how I intend to manage these disadvantages.

iii. The researcher’s reflections: investigation, learning and insight

The final strand of data that I weave into this research is, in many ways, more personal. This has been a very reflexive and iterative research process because I began the project with little more experience in the field of RE than what I gained from the four courses I took as part of my PGD in Sustainable Development at the Sustainability Institute in 2014. Here, I first provide some background information on myself to give the reader an idea of the experiences that have shaped my

thinking and ultimately my approach to this project. Part of the reason that I took such a broad and open-minded approach, for example, is because I wanted to take full advantage of the fact that my thinking on the topic of SSEG PV and RE in general was not shaped by a heavily technical or economic background, but rather a social one, and I therefore aim to provide a different perspective on the topic at hand. Second, I explain the various ways in which I have tried to supplement and keep track of my existing beliefs and feelings towards the topic and how these changed with the learning process.

Background

My undergraduate degree was a Bachelor of Arts from the University of the Witwatersrand, where I majored in Industrial Psychology and Archaeology. My need to question even the most fundamental assumptions was nurtured by the various courses that I took at Wits University, as was my more socialist and less neoliberal approach to development. These seeds were, however, planted by my parents, both of whom were heavily involved in the struggle against Apartheid and in the building of a more equal society in the years that followed. My father went into project management and specialised in social development projects, and my mother is the current Provincial Minister for Finance in Gauteng. My deep values of racial desegregation and equality, as well as my love for the environment, were fostered throughout my upbringing, and in recent years, interactions with both my parents about current events and issues in social development and government have given me a more realistic perspective of what government can actually (and practically) do in terms of guiding development within the space of a term in office. I therefore hope that my perspectives on this topic and on the recommendations that I provide towards the end of this paper are a useful combination of the ideal and the realistic.

Recording the research process

To keep track of my learning process and reflections, I kept a journal throughout this research process and refer to it in the body of this paper when necessary. In order to broaden my knowledge and to familiarise myself with the various actors in this field, I used my connections from the Sustainability Institute, and my mother's friendship circle. I also attended a great number of meetings with various people from organisations such as Green Cape, One World, South African Local Government Association, and the World Wildlife Fund, in addition to the meetings I had with representatives from the Stellenbosch and CCT Municipalities. My entire collection of notes from these meetings has been electronically recorded in a word document and I refer to them as needed. Both these resources will be made available upon request.

d. Conclusion

This chapter has provided a holistic approach towards the discussion of SSEG PV in South Africa as compared to elsewhere. The primary aim is to allow for the actual voices of selected stakeholders to be heard in context. The design of this approach has been informed by complexity and systems thinking and literature on sustainable development, as well as my own background and upbringing. I have explained how this study makes use of a mixed methods methodology, including both quantitative and qualitative research methods that are all analysed with reference to the concepts of triangulation and emergence (borrowed from complexity theory). The research methods include a desktop literature review, a case study (that includes a short survey administered to ten focus group participants, a transcribed focus group discussion with the same ten participants, and three transcribed interviews with key policy and decision makers (directly and indirectly) relevant to the case study context), and reflections on the theoretical perspective offered by complexity theory, systems thinking, and interpretations of sustainable development literature.

3. Chapter 3 – Literature Review

a. Introduction

This chapter will deal with one of the core questions posed in the list of ‘research questions and objectives’ provided in chapter 1, namely:

What alternative approaches towards the idea of DG have been taken elsewhere in the world and how do these approaches compare to the South African context and approach?

This chapter is divided into three sections:

- Section 1: Introduction to DG
- Section 2: Review of case studies
- Section 3: A way forward

The aim is to reveal a collection of different approaches to the design and development of DG systems in 17 countries around the world. An analysis of how these projects are implemented in different contexts is provided. I compile the emerging challenges and suggested opportunities for improvement and use these to argue for an alternative, holistic approach towards DG uptake. This alternative approach has the potential to improve the chances of success in the sustainable uptake and integration of DG uptake and potentially to eliminate certain barriers to this process, before they emerge.

b. Section 1: Introduction to DG

The definition of DG is provided under *Definitions*, at the beginning of this paper. Briefly, DG development involves the design and implementation of smaller energy (electricity, heat and cooling) generation systems located nearby to energy resources and to the consumer (El-Khattam & Salama 2014). These systems include RE

systems to a large extent, but may also be combined with energy generation systems that operate off non-renewable sources and/or energy storage systems in order to manage the limitations of RE. I have focused on reviewing literature published between the years 2008 and 2016, and that deals with the conceptualisation, design, implementation and/or evaluation of DG systems in different communities. The review is conducted to answer three sub-questions:

- 1. What drives the uptake of DG systems in different countries and how are DG technologies selected? (In order to gain general information on each DG case)*
- 2. How were projects designed and implemented?*
- 3. To what extent are these projects considered to be successful?*

I acknowledge that assessing the extent to which these projects are ‘successful’ is a subjective process. This is especially considering the various ways in which the concept of sustainable development can be defined and understood, and the fact that each DG project is considered for different reasons and to fulfil different objectives, making them difficult to compare.

I therefore have two levels on which I choose to assess the success of the cases reviewed. The first way relates to the extent to which the author(s) of each case consider the project a success, depending on whether or not the outcomes of the project are aligned with the initial stated objectives. The second way I will assess the extent to which the proposed projects and their outcomes are helpful in contributing to sustainable development (as defined in the definitions section above) is by considering the extent to which the projects proposed contribute towards the achievement of the UNEP (2016) sustainable development goals. The goal of primary interest is the goal of “...ensuring access to affordable, reliable, sustainable

and modern energy for all...” from modern and renewable energy systems. These goals and their relevance are discussed further in chapter 5.

I explore the different ways in which stakeholders from different countries and contexts navigate the many challenges linked to the design and sustainable implementation of DG system projects. The chosen case studies are grouped according to whether the DG projects were implemented in developing or developed nations, as well as by continent. The cases are briefly described and analysed using the framework above.

The challenges involved in creating and nurturing the growth of socio-economic environments for the development of various RE system industries are experienced across the globe. Thus far, a ‘correct’ and ‘fail safe’ method has not yet been successfully developed anywhere. South Africa is therefore not unique in its struggle to develop local guidelines for how to manage DG initiatives.

ii. **The literature**

There is a vast body of literature on the topic of DG. I chose to focus on collecting peer reviewed journal articles for this literature review because publications are concise and contemporary. They are also more reliable than much of the grey literature on the topic, available online. Initial literature analysis revealed that literature on DG could be roughly divided into eight broad categories according to the aspect of DG implementation that they choose to focus on. Articles were classified according to their main points of focus indicated by their titles and in their abstracts. These categories include literature on the:

1. **Technical aspects of DG:** review of technologies and systems available, their efficiencies, technical challenges related to design, ability to meet demand, and on technical processes of enabling embedded generation and the challenges involved

2. **Policies and policy barriers that enable (or prevent) the uptake of DG systems:** review existing policies and calls for change
3. **Financial aspects for incentivising and financing the uptake of DG systems:** including articles dealing with ownership models and discussions on FiTs, donor funding, tax exemptions, subsidies, net-metering and microenterprise
4. **Ancillary services required for holistic, successful DG implementation:** mini-grids, smart grids as well as alternative conceptualisations of energy production and distribution structure, for example: the development of energy hubs
5. **Design and implementation processes of DG initiatives:** includes discussions of how DG is used to solve a number of problems in various contexts and communities; detailing the geographical contexts, available resources, investigating and articulating community needs and levels of community engagement involved in implementation and follow-up research
6. **Assessments of the effectiveness** of these different examples of DG projects in different contexts
7. **Planning and modelling strategies for potential DG projects:** including discussions of their outcomes and various modelling tools and approaches to planning
8. **Environmental benefits and challenges of DG distributions:** for environment and potential to reduce carbon emissions

It is important to recognise that each article touches on a number of the topics from each category; for example, finance articles may mention the policies that enable or prohibit the success of various financial mechanisms. I focused my interest on categories five and six listed above because these articles draw on elements from all the other categories, providing more holistic pictures of the various contexts in which each DG project or implementation strategy is designed and applied.

iii. Rationale for DG

DG includes generation systems with capacities of between 1MW and 300MW and has become increasingly popular since the idea emerged in the 1970s and 1980s (El Khattam & Salama 2004). Since then, rapid advancements in energy generation and distribution technology have enabled a wide variety of options to enter the market and DG systems can be designed to suit many needs and contexts (Davidson et al 2015; Eltawil & Zhao 2010; Liu et al 2013; Toledo et al 2010; Alvial-Palavicino et al 2011; Minaar 2011; Lillo et al 2015; Han et al 2016; Li 2005). Han et al (2016: 289) also explain that “compared with conventional centralized energy system (CES), a decentralized energy system (DES) [or DG system] employs a wider range of technologies, including prime movers, waste heat recovery, energy storage, heat pump, PV, small-scale wind turbines, and other equipment that use RE resource,” indicating the flexibility of system design and use. Different authors define the capacity range of DG in varying ways and I use the concept of DG to refer to alternative generation models to the traditional, centralised generation model. I therefore consider SSEG PV as falling under the umbrella concept of DG but on a much smaller scale. This is because DG systems in general can also be embedded or free standing, and are smaller than utility scale generation systems required to operate a centralised generation system.

Li (2005) also makes a strong case for the localisation and diversification of energy generation systems, from a sustainability perspective. He illustrates the concept by comparing this to the level of diversification that is found in natural ecosystems,

where biodiversity is recognised as the key to a system's survival. The dominance of any particular organism in a natural ecosystem disrupts the balance of the system and this imbalance often has negative consequences for the rest of the system, threatening its survival. This is compared to the way in which the dominance of large-scale electricity generation systems run on fossil fuels, threatening the survival of both social and natural systems on the planet (Li 2005). Therefore, Li's (2005: 2242) reasoning is in support of increasing energy diversification through increasing the uptake of DG models and is as follows: "...even though each energy system has its own adverse impact on a particular aspect of the environment, if that impact is small enough to allow for the environment to tolerate or withstand (or recover from) the impact, then that energy system may be considered sustainable."

Advantages of DG

Potential advantages of DG systems depend on whether they are designed for urban or rural settings. In rural contexts, DG systems have the potential to provide energy and/or electricity to households, schools, hospitals and businesses that previously went without. In Zambia, for example, one of the key advantages cited by community members involved in a solar PV pilot project (who received small-scale solar PV systems for lighting) was that children were now able to continue working on their homework after the sun set, and children whose homes were not equipped with this technology would congregate at households that did, to work. This was also noted to have improved community cohesion (Ellegard et al 2004).

In Peru, Andean communities also received access to electricity via a number of different kinds of DG systems, including solar PV systems, small scale hydro systems and wind turbines, increasing the number of business opportunities in the area as well as the productive hours of individuals (Lillo et al 2015). DG systems also have the potential to provide greater access to electricity in rural areas at lower cost to governments because, often, costs to expand the grid infrastructure are much higher. DG systems can be constructed more quickly and efficiently than the

expansion of grid infrastructure, which is usually far behind schedule (Domenech et al 2014).

A number of potential advantages of DG apply to both rural and urban contexts. First, DG systems have the potential to reduce overall carbon emissions by reducing the overall demand of grid electricity from centralised electricity networks, in countries whose grid electricity is generated by conventional utility scale systems run on fossil fuels (Davidson et al 2015).

Second, DG system implementation has the potential to enable countries to meet targets for the uptake of RE systems and to diversify their energy mixes (Eltawil & Zhao 2010; Davidson et al 2015; Lillo et al 2015).

Third, these systems are also, by nature, situated close to sources of RE as well as to energy and/or electricity consumers, increasing efficiency and reducing transmission costs and energy losses (Lillo et al 2015; Mehleri et al 2013). Finally, depending on the ownership model and method and manner of implementation, DG systems have the potential to be more empowering for a community or household by reducing their dependence on the state or energy utility for electricity supply (Lillo et al 2015).

The process of identifying and realising the true potential benefits of DG systems is more complex in urban contexts. This is because DG systems often have to be embedded in existing, centralised grid networks. Managing this connection presents many challenges to successful uptake of DG projects in both developed and developing country contexts.

One of the most popular ways of experimenting with integration of DG projects in urban contexts is through the introduction and promotion of small-scale solar PV systems, both embedded and off-grid. In developed countries such as the USA, UK, Italy and Germany, other types of DG systems that supply electricity and other

forms of energy, such as heat, have been implemented (UNEP 2015a). These types of applications are referred to as district energy systems and are less common in developing country contexts, although examples do exist in China and Malaysia (UNEP 2015a).

DG systems have the potential to make electricity supply more secure or reliable in urban contexts, especially in contexts (like South Africa) where the national utility struggles to meet demand for various reasons (Minaar 2016). DG systems can assist with peak load shaving; however, in the case of embedded generators, potential benefits are less obvious because methods to ensure the monitoring and alignment of objectives and targets are often inadequate (Deshmukh et al 2010). An example of where this problem has been well managed can be drawn from the Pacific Island countries, where embedded PV and micro grids have been successfully implemented because the government has clearly stated its aims of reducing carbon emissions in real terms and of reducing their dependency on diesel and fluctuating, increasing oil prices (Raturi et al 2016). The business-as-usual model for electricity generation and distribution in these Pacific Island nations relies heavily on small-scale diesel generators and clearly prevents the achievement of these goals. Thus a largely successful campaign was launched to encourage the uptake of small-scale solar PV systems, both embedded and off-grid (Raturi et al 2016).

I have used the word “potential” when describing the benefits offered by DG systems because whether or not these benefits are actually realised, in real terms, is largely dependent on how their implementation strategies are designed and what method of implementations are used. If any aspect or aspects of this process are done in a problematic manner, these benefits may not be realised, at best, but at worst, there may be far reaching negative consequences (or responses) to the implementation of the project (Lillo et al 2015).

Disadvantages of DG

The potential disadvantages of DG can be technical, political, financial, social and/or conceptual in nature and are largely related to the design and approach to implementation used (Deshmukh et al 2010; Eltawil & Zhao 2010; Antoneli & Desideri 2014). Unfortunately, many barriers to the uptake of DG systems are viewed as disadvantages, even though there are ways of managing them. This section attempts to separate the disadvantages of DG (in general) from the barriers that present themselves to their design and implementation (that can be managed through something like context specific research, for example). These barriers will be discussed in case specific examples in section two, and for now, the disadvantages of the concept and practical development of DG (as opposed to centralised generation) are discussed.

There are two types of technical challenges: challenges and limitations that are related to the capacities and capabilities of renewable energy systems in general, and challenges related to how these DG systems articulate with existing energy and electricity systems (Eltawil & Zhao 2010). The limitations of RE systems in general include intermittency, resource availability, and designing the system to meet the correct needs, while the latter set of challenges includes questions of how to regulate grid connection and maintain grid stability. It is important for technical challenges to be managed appropriately because "...the promising benefits of DES [DG] might be hampered by inappropriate operation strategy. An improper operation strategy would cause the waste of electricity or heat, definitely lowering the system performance. Therefore, there is also a great supply of research about the operation optimization of DES" (Han et al 2016: 290). Embedded generation systems, for example, face many challenges at the point of grid connection because, if handled carelessly, DG systems can upset grid stability because of issues around intermittency of electricity supply from RE sources.

These technical problems can, however, be managed in various ways, as El-Khattam and Salama (2014) and Eltawil and Zhao (2010) explain. Toledo et al (2010) discuss the issue of storage and show that, while a variety of storage technology options are available on the market, further research is required for improvement of that technology and, currently, prices for storage systems are quite high. Storage is important because pairing DG systems with storage of some kind helps manage some intermittency issues and increases the potential for DG systems to assist with peak load shaving. In the case of embedded DG systems that generate electricity, there are technical limits for the amount of electricity the established grid can handle (Wong et al 2011). Extensive (time consuming and costly) grid analyses and the design and implementation of ancillary systems (such as smart grids, micro grids) are required to determine these exact limits in each context, and to develop ways of managing this problem in order to maintain grid stability.

In these cases, a preferred option is to design and connect DG systems to micro grids or to upgrade existing grids to smart grid systems. This process should not be underestimated and has presented significant challenges towards the uptake of DG systems in urban contexts (Toledo et al 2010; Liu 2013). Further studies that compare costs for grid upgrades to costs of building nuclear power stations, for example, may be helpful to gain a better idea of the costs involved to inform decision-making.

The financial and political disadvantages of DG systems emerge when policy changes are required to enable incentivisation, implementation, and grid connection. In some countries, such as South Africa, there is little in the way of local policy to guide the uptake of these systems. As a result, policies have to be changed to provide this guidance, which is a potentially time consuming and convoluted process due to inefficiency, lack of political will or buy in, conflicting objectives, or insufficient funding available (Deshmukh et al 2010). Financial incentives are often required due to the high capital cost of DG development. As a result, well

intentioned, financial incentives are difficult to design and may have unintended consequences due to poor planning and inaccurate predictions of market behaviour (Muhammad-Sukki et al 2013). This is clearly demonstrated in some of the case studies to follow. Many developing countries are also unable to afford subsidies, FiTs or net-metering systems to encourage the implementation of DG systems, and, as a result, have to rely on securing donor funding (Lillo et al 2015).

There are also ways in which the complexity of social systems interferes with the successful implementation of DG projects if they are not appropriately managed from the early stages of conception and design. Several authors, such as Deshmukh (2010), McDermont (2014) and Davidson (2015), have raised this issue. These authors also note that social issues, such as a lack of transparency and inclusivity in project processes, a lack of education on the system and its functioning, a lack of skills development, a misidentification of consumer need, and a lack of incentive and philosophical or ideological buy-in, can contribute to the unsustainable project implementation (Deshmukh 2010; McDermont 2014; Davidson 2015). This in turn reflects poorly on the technological systems themselves and inhibits market growth.

The most fundamental challenge to the uptake of DG (and ultimately the most serious disadvantage) is that successful changes towards DG requires a substantial paradigm shift in the way people think about electricity. McDermont (2014), Alvial-Palavicino et al (2011), Lillo et al (2015), Liu (2013), Li (2005) and El-Khattam and Salama (2014) all strongly argue for a paradigm shift that takes a more holistic, less technical, perspective on electricity and energy generation and distribution, and that includes the recognition and commitment to the need for change, the prioritisation of climate change mitigation strategies, a greater emphasis placed on the potential roles of consumers as simultaneously being *prosumers* (electricity consumers who also generate electricity), engagement with stakeholders, and the development of feasible, sustainable (rather than profitable and quick) solutions to energy and electricity challenges. Consumers in turn need to shift their perception of electricity towards the notion that electricity is a resource that is to be used responsibly rather

than as a commodity to be exploited and wastefully consumed, and that they themselves can become generators in addition to being consumers (McDermont 2014).

Raturi et al (2016) provide an example of this using a discussion of case studies from Pacific Island countries and their success. A further example can be drawn from achievements in Costa Rica showing first hand that this approach can be successful and therefore that it is not impossible (Wilder-Ramsing & Potter 2008).

While there are many disadvantages and challenges associated with the experimentation and development of DG in general, this alternative approach to the organisation of electricity and energy generation offers great potential to contribute to sustainable development. This includes supporting initiatives to decrease reliance on fossil fuels (and therefore a decrease in GHG emissions), diversify energy mixes, increase access to electricity in rural areas, and assist with peak load shaving. All of these are necessary given the global climate change related issues, as well as issues relating to the increasing prices of finite fossil fuel resources (Bardi 2009; Murphy & Hall 2011).

Authors, such as Han et al (2016: 290), advocate for a multidimensional approach to the design and implementation of DG systems to increase their chances of success. In the following section, I provide an analysis of seventeen case studies, from seventeen different countries, detailing the various ways in which stakeholders in each region experiment with DG design and implementation approaches in order to managed the various emerging challenges to ensuring sustainable uptake to these systems.

c. Section 2: Review of case studies

From the collection of articles reviewed, 16 countries emerged as being the most prominent in terms of studies conducted on the effectiveness of various types of DG

projects implemented in varying contexts and for varying reasons. I organised these countries by continent, as follows:

- **Africa:** Kenya, Tanzania, Zambia, Nigeria, South Africa
- **Asia:** India, China, Malaysia
- **Europe and Australia:** the United Kingdom, Germany, Italy, Australia
- **South and Central America:** Brazil, Peru, Costa Rica

This list is by no means exhaustive, however it serves to give the reader a sense of how widespread experimentation with DG systems is. The topics of discussion for each continent include a discussion on each of the following points (in answer to each of the three questions phrased earlier):

1. **General information:** whether the examples illustrate urban or rural DG applications, and, briefly, what technology is used, the main reasons for the choice of application and the need it was designed to meet, the types of ownership models of the DG systems, and the ways in which the applications were enabled financially and in terms of policy.
2. **Methods of implementation:** How each project was designed and implemented, the degree of social inclusion or consumer consultation conducted, the environmental considerations made, whether or not targets and monitoring processes were implemented, and the extent to which capacity building was considered for sustainability.
3. **The analysis:** any barriers to uptake raised, any opportunities for improvement suggested, and, finally, how the findings could be relevant to this research.

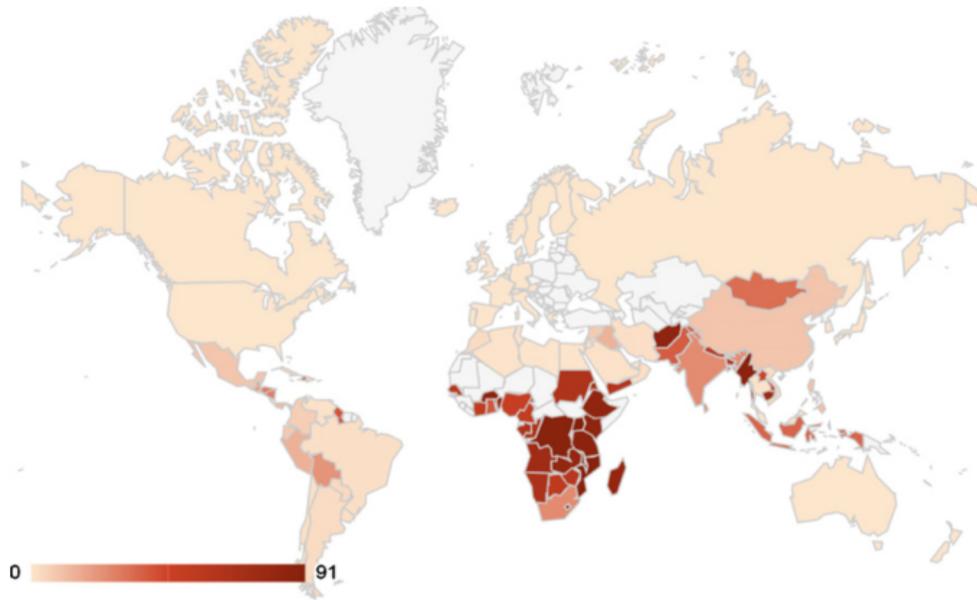


Fig. 2. Percentage of population with no access to electricity [34–35].

Figure 7: Percentages of the global population, by country, without electricity access (Source: Mohammed, Y.S., Mustafa, M.W., Bashir, N. & Mokhtar, A.S., 2013)

i. Africa

Africa is recognised as a continent with extensive development potential, however, countries on this continent face substantial sustainability challenges. This is due to their need to promote economic growth and development without placing the same level of demands on the earth and its resources as developed countries did throughout the course of their history. Swilling (2013) argues that the planet cannot withstand such exponential development if done in the traditional, resource intensive manner. Thus, African and other developing countries need to find ways of growing their economies in efficient, sustainable ways while simultaneously promoting social equality and managing and mitigating climate change as well as other ecological constraints and damage (Swilling 2013).

South Africa is classified as one of Africa's developing countries by the United Nations (2012) and faces many of the social, political, environmental and economic

challenges to those faced in other developing nations on the continent. South Africa is also, however, one of the most developed countries on the continent, making the developmental context fairly unique. The review of approaches towards the energy development and RE uptake (and DG) that other African nations take is therefore relevant to South Africa in more general ways (Swilling 2013).

Introduction:

What drives the uptake of DG systems in different African countries and how are DG technologies selected?

DG systems in Zambia, Kenya, Tanzania and Nigeria are implemented in both rural and urban areas and are driven by a combination of need and affordability. The factors that inform the choices of DG system technology types that are applied in each country, however, are not necessarily informed by practical considerations, but often by proximity to RE markets in neighbouring countries, or by donations made to governments by private companies or NGOs.

Briefly, the types of DG systems explored range from the promotion of small-scale, stand-alone 50 Wp solar home systems, as implemented in Zambia (Ellegard et al 2004), to the promotion of markets for the uptake of embedded solar PV systems in Tanzania and Kenya. While Kenya has managed to achieve great success in the development of a more sustainable residential scale solar PV market than both Tanzania and South Africa thus far, research in Tanzania illustrates a more creative way of utilising a FiT for mini-grid systems (Ondrazek 2013; Moner-Girona 2010). The South African context will be discussed in more detail in the following chapters, however it is worth mentioning that this country lacks significant policy guidance for local governments to engage with ways of conceptualising and implementing small to medium-scale DG system possibilities. Instead, the South African national government supports the inclusion of large, utility scale DG projects to take advantage of the country's vast solar and wind RE resources

(Mienaar 2016). The example drawn from Nigeria (Mohammad et al 2013) indicates the country is still in the process of reviewing their RE resources, and is in the early stages of researching and conceptualising types of small to medium stand-alone DG projects to supply electricity and energy to areas lacking grid access. This provides an idea of the ways in which DG systems are used in the selected African countries.

The reasons for selecting to implement DG applications vary from country to country, as do the ownership models chosen, and depend on the finance and policy initiatives that are designed to create and incentivise the development of enabling environments for their uptake.

The distribution of 50Wp solar home systems in Zambia was motivated by aims to increase access to electricity in rural areas for lighting and entertainment, and therefore these systems were designed to power four lights in each household and provided two plug points for a television, radio or mobile phone charger. The project described by Ellegard et al (2004) is a pilot project where the solar home system (SHS) manufacturer donated the systems to the government. The government, in turn, leased them out to small energy service companies (ESCOs) in local areas. The ESCOs then rented each system out to individual households in rural villages in Zambia at affordable prices. The agreement between government and ESCOs included that the ESCO would purchase the solar PV systems from the government in monthly instalments, over a period of 20 years. Ellegard et al (2004) do not explicitly mention the exact policies that enabled this arrangement, however the authors do explain government support of the programme because it is aligned with aims of reducing poverty and increasing quality of life in impoverished areas by expanding access to electricity. There is also the possibility for this pilot project to be implemented in other areas, even though serious challenges were experienced because defective components of technology systems were donated instead of fully functioning systems. This shows the extent to which developing countries can be

reliant on international support to manage the complex challenges they face, particularly where the implementation of RE solutions is concerned.

The uptake of off-grid residential scale solar PV systems in neighbouring countries, Kenya and Tanzania, was largely motivated by communities' need and desire for entertainment, communication and other electronic appliances. The uptake of solar home systems began in Kenya with the expansion of radio and television signals into rural areas and, as the market grew, it began to spill into Tanzania (Ondrazek 2013). In Kenya, a combination of increased spending power in rural households (due to a boom in the agriculture market) and subsidies from government and NGO donor funding meant that many rural households were able to purchase a SHS.

Market growth and overall uptake of SHS has been slower in Tanzania, despite some incentives offered by the government. This is partly because it was not preceded by agricultural sector growth, and, as a result, the market did not expand to local manufacturing of PV technology and local provision of ancillary products and services such as inverter retailers and installation companies, as it did in Kenya (Ondrazek 2013). This shows that timing is important for market growth and that it is more likely to occur if it is supported and integrated with growth in other sectors; focusing on only incentivising a particular system may not have the desired result.

In South Africa, there are a number of reasons for introducing the Renewable Energy Independent Power Producer Procurement Programme (REIPPPP). These are to increase the country's national energy mix, supply increasing electricity demand due to population growth, grid expansion, and to provide generation capacity and support to a struggling power utility founded on out-dated conventional coal-fired generation technology (Mienaar 2016). The reduction of carbon gas emissions is also identified as an important driver, as South Africa is the continent's largest emitter of GHGs. Private companies own the utility scale projects and have power to purchase agreements, with the state-owned power utility Eskom, to sell and feed electricity generated back to the national grid. South Africa

is fortunate enough to have supportive national policy to direct this initiative and to be able to design an initiative that integrates a number of development goals such as social upliftment, increasing electricity supply, and reducing carbon emissions, although there are challenges in transparent and just application of these project goals in some cases, at local, project level (Mienaar 2016). This shows that, while national policy can be hugely supportive, there are limitations to the extent to which policy can ensure just, long-term benefits are realised without the implementation of proper monitoring and assessment processes that are taken seriously. Another limitation is that this policy only guides DG projects and there is much confusion as to how demand for SSEG should be handled by local government. This is examined in more detail in the next chapter and is ultimately the focus of this research.

Similar reasons are cited to justify research and experimentation with DG projects in Nigeria. These involve meeting increasing electricity demand (where currently only “...40% of households in the whole country have access to the public [electricity] utility”) while simultaneously keeping carbon emissions to a minimum (Mohammad et al 2013: 259). This is of particular concern in Nigeria because the national grid is in a poor state and most electricity consumers meet their own demands with diesel generators, making a business-as-usual model highly problematic from an environmental and social wellbeing perspective (Mohammad et al 2013).

Although Nigeria is a country with vast renewable and non-renewable resources, Mohammad et al (2013) show that only a handful of residential scale solar PV systems have been installed in wealthier, urban households and that the technology is still largely inaccessible to the majority of the population. Mohammad et al's (2013) research also reveals that a lack of funding and political will are reasons for why there is a lack of interest expressed in the potential of DG systems for Nigeria, along with a lack of public awareness, education, and training to promote research into and expansion of options proposed for the public to consider. This shows that the integrated nature of the barriers to the uptake of DG systems, despite the

systems' potential benefits, will need to be coherently addressed if, and when, the Nigerian government wishes to investigate DG options, because any of the issues raised have the potential to derail such efforts.

Each country therefore has different priorities that inform their approaches to engaging with ways of integrating and managing the complex sustainability and developmental goals and challenges they face as developing countries.

Implementation methods and analysis:

What enabling mechanisms were used and to what extent were these considered successful by the authors? To what extent are these projects considered sustainable development projects?

In the cases of Kenya and Zambia, where donations (funding as well as technology systems) and government incentives dictated the type of DG applications used (namely off-grid solar home systems), consumer consultation (albeit limited) was conducted in both cases. In both these countries, the uptake of these systems and the development of more robust markets and supporting businesses emerged primarily because each project catered for explicit needs in the respective communities and were made affordable, instead of remaining exclusive and expensive (Ellegard et al 2004; Ondrazek 2013). Both these DG projects included training and education programmes that enabled a degree of autonomy amongst solar PV customers and the development of businesses and ancillary services, whereas in Tanzania, where this kind of 'extra' development was neglected, the market developed more slowly and has been more dependent on government support in the long term (Ondrazek 2013).

The DG solutions in Kenya and Zambia are therefore considered more successful than in the case of Tanzania because market growth in Kenya was more diverse. In all three cases, however, concerns are raised about what the procedure would be in

the event that the national electricity grid expands into areas where the solar PV systems have already been installed. Questions as to what implications this could have for the emerging solar PV market are also raised and are a cause of great uncertainty (Ondraček 2013). This highlights a lack of long-term planning and calls into question the sustainability of the solar PV market growth. Another concern is that none of these three case studies involved target setting to guide the uptake of the technology systems or the amount of energy generated from RE resources. Ondraček (2013) and Ellegard et al (2002) argue that this level of uncertainty due to lack of policy guidance and target setting severely limits the long-term sustainability of the solar PV markets.

These case studies indicate the important supporting role that consumer consultation, capacity building, and the nurturing of more flexible markets can play in the development and implementation of DG systems. Governments would benefit from creating more flexible markets by taking long-term, integrated approaches to planning and guiding such endeavours (Ondraček 2013). Urpelainen (2014) reiterates this point and identifies the lack of integration between grid expansion policies and those supporting the uptake of DG systems in rural areas (using another example in India) to be highly problematic for the development of sustainable, long-term energy solutions.

Nigeria and South Africa are still in the early stages of planning and managing the design and uptake of DG systems at utility, commercial and residential scale. Unfortunately, neither case study provides evidence to suggest that priority shall be given to future social engagement or consumer consultation processes that could provide information to better ensure gender equality and opportunities for the empowerment of women and girls or "...ensuring access to affordable, reliable, sustainable and modern energy for all..." (UNEP 2015b). This throws into question the issue of whether these projects will meet the social criteria for sustainable development. In the case of South Africa's RE bid programme, the responsibility lies with the developer to design the project and to include social, environmental

and technical developmental goals. However, the processes that developers use to gain such information that informs design are not specified (Mienaar 2016). This research paper aims to bring the voice of the consumer into the discussion, and the findings highlight several reasons why this process could be beneficial to policy and decision makers, as well as to stakeholders in the solar PV industry and, above all, to the potential consumer.

ii. Asia

Asia includes two of the most rapidly developing countries, fastest growing economies, and largest human populations on the planet: China and India (Behrens et al 2007). Developmental challenges in these countries also involve the need to expand electricity access to rural areas, redesign energy access in urban areas in order to increase supply to meet increasing demand, minimise the barriers to the uptake of RE systems, and diversify energy use through the use of DG systems. Malaysia, like South Africa, is currently grappling with the challenges of ethically promoting the uptake of embedded solar PV generation at residential scale given the vast socio-economic disparities between sections of the population (Koh & Lim 2013).

Introduction (general information):

What drives the uptake of DG systems in different Asian countries and how are DG technologies selected?

The case studies chosen from India and Malaysia include small-scale solar PV technology, while the case study from China include examples of hybrid decentralised generation systems (or DG systems). These hybrid systems are in the form of gas-fired combined cooling, heat and power systems with renewable energy

technology (primarily solar or wind electricity generation systems) (Deshmukh et al 2010; Ahmad et al 2015; Urpelainen 2014).

The ambitious Jawaharlal Nehru National Solar Mission (JNNSM) – a government initiative that aims to bring 22 GW of solar energy online by 2022 – serves as a guideline for the uptake of solar energy generation technology and to facilitate the growth of a sustainable PV market in India. The policy, however, does not provide guidance for integrated, multidimensional development linked to DG development. The case study provided by Deshmukh et al (2010) focuses on a critique of this policy for two main reasons: first, targets are believed to be unrealistic and, second, for prioritising the uptake of small-scale, off-grid solar PV systems above other forms of PV technology such as PV powered lighting systems. This is considered problematic by Deshmukh et al (2010) because prioritising off-grid solar PV systems is not aligned to community needs, as these systems are largely unaffordable.

Deshmukh et al (2010) therefore suggest an alternative approach. Instead of targeting individual rural households (the owners of which are likely unable to afford solar home systems), Deshmukh et al (2010) argue that meeting the lighting needs of the community should be prioritised and that solar powered lighting should be installed on streets in rural areas as well as in hospitals and schools. The government would retain ownership of the lighting system. Deshmukh et al (2010) show this to be cost effective for both the residents and the government, and argue that their suggested solution would increase quality of life, enable savings on kerosene, and extend productive work hours into the evenings and early mornings. This is an interesting approach of breaking down electricity needs and using a particular technology for a particular need instead of trying to ensure that one type of technology system is able to meet all the needs. Urpelainen (2014) further strengthens the argument that DG policy should be integrated with other developmental goals to increase sustainability, ensure that the benefits of DG

systems are realised, and ensure that the poor are not left out of electricity supply projects.

China's response to projected increases in electricity demand includes a strategy to focus on installing urban gas-fired combined cooling, heat and power systems (CCHP). In addition to the growing population's, and economy's, increasing needs for electricity, there is the recognition that the country needs to drastically reduce their carbon gas emissions. This is another major driver for the uptake of DG because China, alone, was responsible for 27.5% of the world's emissions in 2014 (Han et al 2016). This type of DG system design is selected because it is considered more flexible in terms of meeting different needs (such as for steam, heat, cooling or electricity), and because the technology is able to address many of the challenges and barriers presented by China's coal dominated, centralised electricity system. These CCHP systems are also designed to assist with load peak shaving and much emphasis is placed on system optimisation (Han et al 2014).

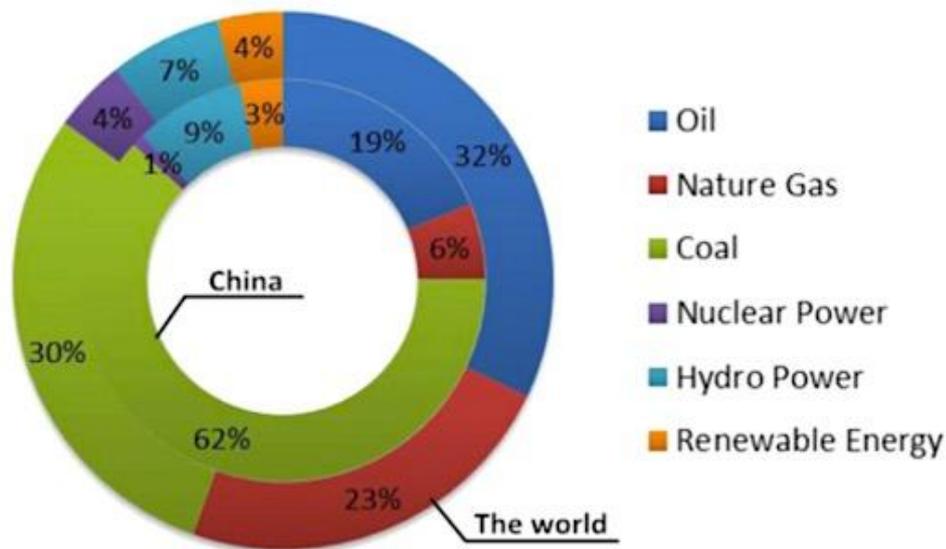


Fig. 2. Energy consumption structures of China and the World.

Figure 8: China's energy consumption, by resource, as compared to the rest of the world (Source: Han, J., Ouyang, L., Xu, Y., Zeng, R., Kang, S. & Zhang, G., 2016)

Liu et al (2013) provide an analysis of one of the first gas fired CCHP projects that was supposed to be designed and installed in the Fujian Province in 2011. The project was designed to meet the electricity and steam needs of the Jimei Machinery Industrial Park, however it was sadly not completed in time. Liu et al (2013) conducted a stakeholder analysis that revealed the reasons for the delay. First, there was a conflict of interests between the developer, the national grid authority and the natural gas supplier. It was determined that a more open market for natural gas should be facilitated in China. Second, difficulties arose relating to how to design and implement a FiT scheme that is reasonable enough to ensure the viability of DG projects in China. These challenges of stakeholder disagreement, limited multidimensional growth in the energy sector, and designing a successful FiT are not unique to China and exist in South Africa as well. The Chinese government aims to address these challenges by implementing serious policy changes and to announce rules to guide the development of FiTs, "...standards for the applications and constructions of DE projects, technical manuals and managements for the connection with electric grid, 50% or more added-value tax reduction for DE projects and more rewards for energy saving and emission reduction..." (Liu et al 2013: 270). This government therefore aims to be in full control of the process to ensure that it runs more smoothly and efficiently in future. The uptake of China's gas-fired CCHP systems forms part of China's 12th five year plan, and targets are set at reaching 50 GW of installed DG system capacity by 2020. A comprehensive policy plan to guide this uptake is in place with adequate financial incentives. Targets also relate to the number of installed systems as well as efficiency targets for various system designs. Han et al (2016), however, acknowledge that China could improve its FiT scheme further.

The image below represents the design of China's prioritised hybrid gas-fired CCHP system with solar PV system used to service buildings (unspecified).

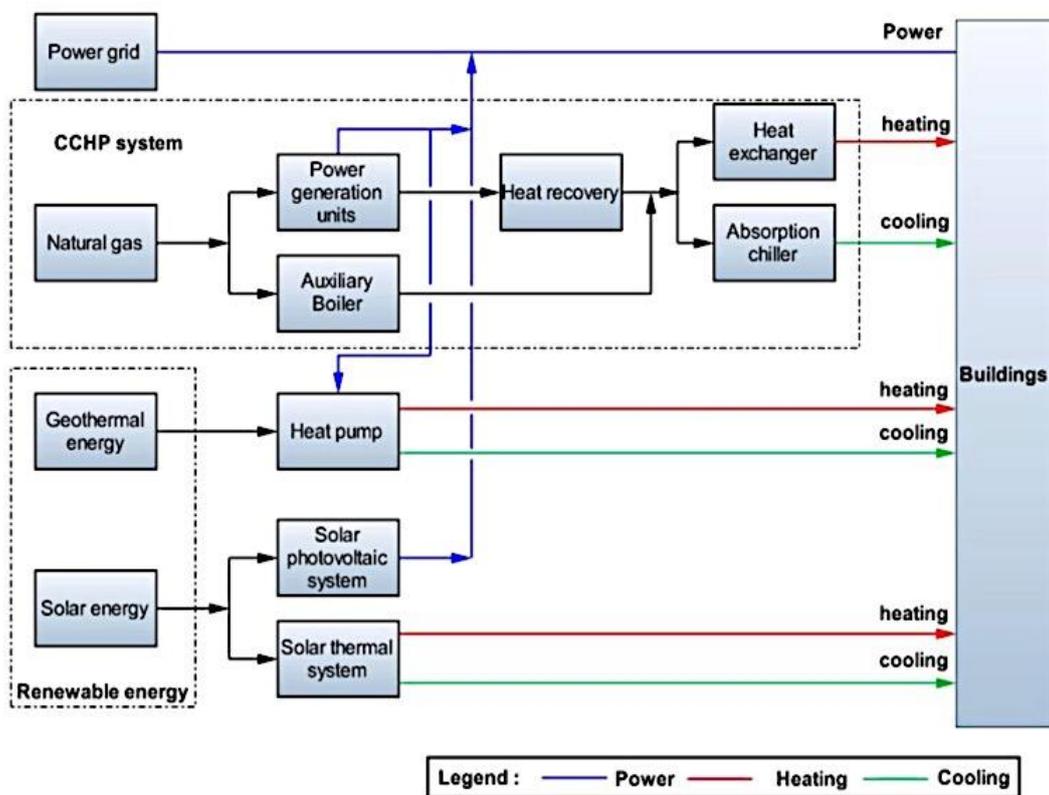


Fig. 4. Typical hybrid energy system configuration.

Figure 9: Structure of a hybrid DG system, similar to those implemented in China (Source: Han, J., Ouyang, L., Xu, Y., Zeng, R., Kang, S. & Zhang, G., 2016)

The Malaysian population, much like the South African one, consists of a rich minority and poor majority in terms of socio-economic development, with a large gap between them. The wealthier group aspires to installing embedded solar PV systems in their homes whereas those in the lower socio-economic bracket have limited (or no) access to electricity, which is very similar to the South African context.

This case study engages with the ways in which the Malaysian government manages the complexities around the implementation of a FiT in this kind of context (Koh & Lim 2010). Ahmad et al (2015) describe the general awareness, in Malaysia, of the adverse socio-economic and environmental pressures placed on the planet and its inhabitants by the effects of global warming and increasing electricity price due to

their reliance on finite resources. They argue that Malaysia is therefore considering enabling a FiT to incentivise the uptake of residential scale, embedded solar PV systems to reduce their dependence on dwindling oil reserves. Koh & Lim (2013) use the example drawn from Saba Province to illustrate another driver for DG in Malaysia: the aim to secure electricity supply in some areas. Here, three alternative DG options are put forward as financially viable alternatives (a hydropower plant, a biomass plan or a connection to the Bakun Dam project) to the construction of a new coal-fired power station. The government supports the construction of the coal-fired power station to manage the electricity shortages experienced in the region; however, the local community and various NGOs are opposed to the idea for health and environmental reasons. In this case, the government policy supports the diversification and distribution of electricity generation; practically, however, the embedded solar PV incentive is the only idea that is currently being considered in the country in general.

Implementation methods and analysis:

What enabling mechanisms were used and to what extent were these considered successful by the authors? To what extent are these projects considered sustainable development projects?

The Jawaharlal Nehru National Solar Mission (JNNSM) in India explicitly promises that social engagement and transparency will be fundamental in the design and implementation processes; however, this was not the case in reality (Deshmukh et al 2010). This breeds a lack of trust between government and other stakeholders and investors, and can significantly derail projects promoting DG, limiting potential for successful implementation. As a result, the government initiative that prioritised the uptake of embedded solar PV systems and the growth of a solar PV market was not aligned to community needs.

Sharma et al (2012) provide another, more detailed, discussion on the solar energy market in India and a more detailed explanation of the effects of the JNNSM. They show that the call for installation of rural lighting has been included, and, while Deshmukh et al (2010) argued for a greater prioritisation of the rural solar lighting project, Sharma et al (2012) describe a more hopeful scenario. Comprehensive plans (policies, laws and financial incentives) allude to the determined and aggressive strategy the Indian government is taking to ensure substantial growth in the solar energy market, including the solar PV sector. However, consumer consultation or social engagement at planning stages are still not mentioned or prioritised, indicating that trust issues may still exist as they had not been resolved a year after Deshmukh et al (2010) raised the issue. Whether or not the JNNSM will be successful can only be assessed in 2022, by which stage India should have 22 GW of installed capacity from renewable energy sources and DG systems. Deshmukh et al's (2010) call for greater public inclusion to ensure the success of missions such as the JNNSM, therefore, remains valid.

Consumer consultation and social engagement are given limited attention in China as well. Instead, Han et al (2016: 292, my emphasis) explain that “ the optimal results and performances of DES [distributed energy systems] are closely linked to the **building's energy demands...**”, and not to human or community needs or demand. The Chinese government therefore prioritises research into what is practically required for a building to operate efficiently, and the findings of this technician research inform the design of the product provided to consumers. I have not been able to find details of the effects of this strategy on the communities who live in the designated buildings. However, overall, the uptake of DG systems of this nature has been reported as being successful, and while these energy systems are not the primary energy suppliers in China, their uptake is rapidly increasing (Han et al 2016). From a review of the various DG projects implemented in China, Han et al (2016) also emphasise that those that were most successful were designed and

implemented using a holistic approach – albeit under strict government control that is unlikely to occur in South Africa.

Malaysia takes a different approach to the development of their FiT. The FiT is enabled by a 1.6% increase to the national electricity tariffs for all households who use more than 300 kW of electricity per month; thus, electricity consumers from lower income households are protected from financing privileges for the rich. Although this is a considerate way of financing a FiT, embedded solar PV remains unaffordable to the low-income households, even if the incentive is highly attractive.

Wong et al (2011) also point out that there are still technical limitations to the uptake of embedded solar PV and therefore to the development of a solar PV market, even with an attractive FiT. This is because, after a certain point, intermittent feed-in threatens grid stability, and therefore plans for the promotion of embedded solar PV need to be aligned with national grid development and upgrade plans. If neglected, these technical limitations pose serious limitations to the long-term growth of a solar PV market, and therefore Wong et al (2011) strongly argue that, before financial incentives can even be considered, governments need to ensure there are sound reasons and objectives behind the incentives guided by research, and plans to upgrade the network so that markets have space to develop. Zahurul et al (2016: 978) introduce the idea of upgrades for smart grids in Malaysia as a way of managing some of the technical limitations, and suggest that a “...plausible way of this integration is the enhancement of information and bidirectional communication infrastructure for energy monitoring and controlling facilities.” This article also suggests some of these technical systems that are currently available on the market for consideration – the basics of which are illustrated in the image below. The image shows the different ways of transporting and storing vast quantities of information from the smart grid system.

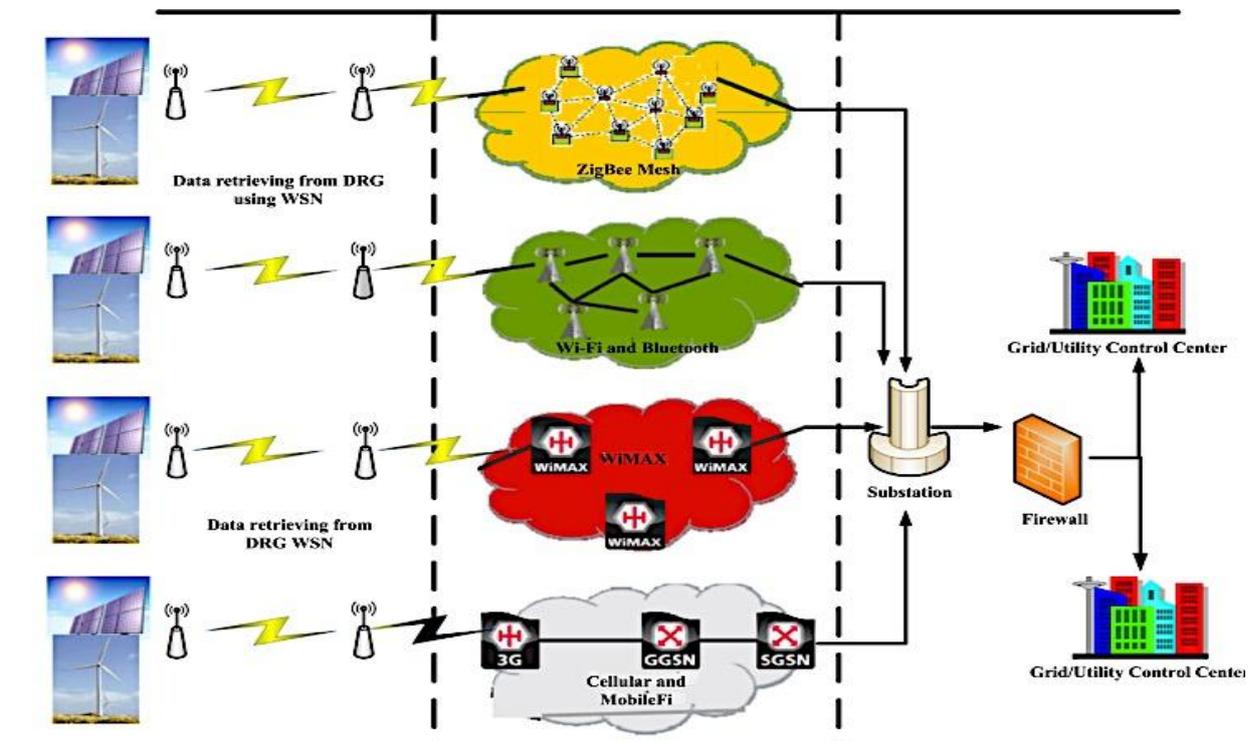


Figure 10: Ways to manage bidirectional flow of information and energy using smart grid solutions (Source: Zahurul, S., Mariun, N., Grozescu, I.V., Tsuyoshi, H., Mitani, Y., Othman, M.L., Hizam, H. & Abidin, I.Z., 2016)

iii. Europe and Australia

The European and Australian (grouped together because they are all developed countries) contexts are vastly different to the developing country contexts described above. Developed countries face different sets of challenges when it comes to distributed (or small-scale energy and electricity) generation.

This discussion is relevant to this topic and to South Africa because South Africa is a unique example of a developing country that shares aspects of its economy and infrastructure with those of a developed nation. It is important to examine these challenges, their outcomes and proposed opportunities for improvement in developed country contexts for two reasons: first, because some challenges may be

similar to those faced in South Africa, particularly with regards to recent policy changes made to enable FiTs for embedded solar PV that benefit the wealthy minority of the population, and, second, because various lessons can be learned from European and Australian contexts about the emerging limitations and potential consequences to avoid when considering the use of FiT schemes to incentivise the development of solar PV markets.

Introduction (general information):

What drives the uptake of DG systems in different European countries and how are DG technologies selected?

The UK, Italy, Germany and Australia have all engaged with DG, especially with ways of incentivising small-scale embedded solar PV systems. Even though developed countries such as these are not dependent on donor funding, and therefore have relative freedom to design and implement DG projects that cater for specific needs, they also experience financial and technical challenges with regards to the implementation of embedded DG.

Cherrington et al (2013), for example, explain how the UK government has had to propose significant FiT reductions because of the mounting financial burden on the government. Muhammad-Sukki et al (2014) indicate that the drivers for using a FiT are to create a more secure environment for homeowners, and others, to consider investing in solar PV technology, and that the drivers for the uptake of PV technology and the FiT are policy targets for 15% of electricity to be generated by installed RE generators by 2020. Both Cherrington et al (2013) and Muhammad-Sukki et al (2013) assess the effects of the tariff reduction on the solar PV market. These researchers also find that the solar PV market is limited by the availability of raw materials required for the manufacturing of solar PV systems and suggest the addition of more long-term policies to guide the decommissioning and recycling of solar PV systems.

Antonelli and Desideri (2014) show how Italy's generous, uncapped FiT has driven the rapid uptake of solar PV systems in some parts of the country. As a result, Italy is considered to have one of the largest solar PV markets in the world. The Italian government, however, had to introduce tariff caps in 2012, and these caps revealed serious market development flaws undermining the stability of the Italian solar PV market. This raises questions about the extent to which the FiT was an effective incentive to assist in the achievement of the goals (to open the solar PV market in Italy, reduce carbon emissions, and increase the uptake of RE systems) as well as the extent to which this contributed to sustainable development.

The chosen case study in Germany includes a projection of the future needs, as the country's electricity system becomes more decentralised and more reliant on electricity generated from a range of renewable energy systems. The main challenge is that most of these systems, of various sizes, are located primarily in the north of the country, when the greatest demand for electricity is in the south (Babrowski et al 2015). It is suggested that Germany may need to consider and plan for the installation of distributed storage systems at strategic points in the grid to manage increasing intermittency issues. The main driver in this case would be to maintain grid stability. This article was of particular interest because it offers a different way of thinking about DG challenges and solutions, for example, the installation of storage systems only, instead of increasing generation capacity to manage intermittency.

Further research into the development of a range of affordable and efficient storage systems is necessary in order to make this strategy accessible to other countries. In developing countries, the lack of affordable, efficient and ecologically friendly storage solutions poses a barrier to the uptake of DG technology and the design of DG (Toledo et al 2010; Babrowski et al 2015; Wolsink 2012). Additional drivers for the uptake of DG systems and applications are in the form of policies to support uptake of renewable energy capacity that have set the target of 60% RE generated

and used by 2040 (Babrowski et al 2015). This target guides the research and suggestions made for the future development of their DG systems.

There are also other, more widely stated, drivers for the uptake of DG in European contexts. While there is general consensus that DG has the potential to reduce carbon emissions (by reducing reliance on conventional power generation systems), DG systems also represent cost effective, energy efficient alternatives to meeting increasing electricity demand in urban areas (Cherrington et al 2013; Cossent et al 2013; Mehleri et al 2013).

The ownership models vary according to each project type. In the UK and Italy, private ownership models are suggested for SSEG PV. However, the more collective DG projects, such as those suggested for Germany could include state ownership, private ownership or a combination of the two (Cherrington et al 2013; Antonelli & Desideri 2014).

The uptake of embedded PV, and therefore the SSEG PV market, in Australia is considered to have been one of the most rapid and successful to date. Australia has a centralised electricity system, however, unlike South Africa, there are a 17 electricity utilities across the country. Electricity and SSEG PV FiT are loosely regulated by the Federal government, however, each state government is free to design and manage SSEG PV uptake and incentives (Mountain & Szuster 2015).

Solar PV is most popular at residential scale where homeowners invest in and own a system to supplement their own electricity usage and to sell excess electricity generated back to the grid. This is because grid electricity tariffs and network charges are especially high in Australia as compared to other developed countries such as Japan and those in Europe and the USA and because of declining solar PV prices in the country (Mountain & Szuster 2015).

The holistic and committed approach taken by the Australian government and the strong role homeowners have played in influencing embedded PV policy, along with a range of generous financial incentives have also contributed to a significant increase in installed SSEG PV capacity at residential scale (Mountain & Szuster 2015). The table below shows the rapid increase in installed rooftop PV capacity between the years 2005- 2013.

Table 1. Cumulative installed PV systems in Australia (MW), 2005-2013 (based on [3])

Sub-market	2005	2006	2007	2008	2009	2010	2011	2012	2013
Off-grid residential	20	24	28	33	41	44	55	65	74
Off-grid other	33	37	39	41	43	44	47	53	58
Grid-distributed	7	9	15	30	101	480	1268	2276	3070
Grid-central	0.8	0.8	1	1.3	2.5	4	7	22	24
Total	61	70	82	105	187	571	1377	2415	3225

Table 3: Table showing the increased installed PV capacity in Australia between 2005-2013. (source: Outhred & Retnanestri 2015: 122).

The expansion of the market was so rapid , however, that the government had to scale back on the incentives offered in order to make them more affordable for governments. This is similar to the UK and Italian case studies described above and presents a significant concern for South African local governments who want to avoid this “boom-bust” pattern of embedded PV uptake because the consequence is that electricity consumers are left with further increased electricity tariffs to finance the incentives well into the future. This may not be affordable to the majority of South Africans.

All these countries therefore have their own objectives, supportive policies, and various financial incentives. The implementation methods used in the UK and Italy are now discussed and assessed in terms of the extent to which they assist these countries in meeting their stated targets and objectives. I also discuss the extent to which the initiatives are considered successful by the authors, and what they suggest could be done to improve implementation in order to better align them with sustainable development goals.

Implementation methods and analysis:

What enabling mechanisms were used and to what extent were these considered successful by the authors? To what extent are these projects considered sustainable development projects?

Governments in the UK and in Italy experimented with a FiT (and supporting policies) for small-scale embedded solar PV. These were intended to serve as the enabling mechanisms for the uptake of these systems.

The UK's micro generation strategy outlines support for the uptake of SSEG and is complemented by the 2009 RE Directive. This policy outlines RE generation targets for 2020. The target is that 15% of electricity in the UK will be generated by renewable energy systems by 2020 that shall be facilitated by three types of financial incentives. First, tax (VAT) reductions are allowed to incentivise the purchase of small-scale generation technology. Second, RE system owners have the option of applying for 'renewable obligation certificates' and of earning an amount per kW of renewable energy generated. Third system owners can also apply for a FiT to earn an amount per kW sold back to the national grid, thereby creating a very strong profit incentive for solar PV system owners (Cherrington et al 2013).

However, Neither Cherrington et al (2013) nor Muhammad-Sukki et al (2013) mentioned any consumer consultation or social engagement processes at any stage of the policy, objective, or target setting stages of this initiative. The primary basis for the FiT design was an assumption that consumers will engage if there is a profit incentive. While this assumption proved correct, to an extent, the strategy unfortunately backfired. Due to increasing financial burden, the government suddenly announced significant reductions in the FiT, attempting to adjust the incentive from being profit-orientated to being savings-orientated. Various stakeholders took the matter to court where it was initially declared illegal (because

the government had only given a few months). The changes, however, have since been made.

Before the change, Cherrington et al (2013) estimated that 25000 jobs were created from market growth and suggest that carbon emissions may have been decreased, but without targets and monitoring systems mentioned in either article, assessing success is difficult. Furthermore, Muhammad-Sukki et al (2013) explain that there was a spike in the numbers of installations done ahead of the date that the policy change would come into effect, with a substantial decrease in uptake after the change was made. Overall, Muhammad-Sukki et al (2013) therefore describe a bleak outlook for the future of the solar PV market in the UK. While the FiT was shown to be successful in encouraging uptake of embedded solar PV systems, the fact remains that there was a decrease in uptake of solar PV systems after the reductions in the FiT were made. This questions the sustainability, independence and flexibility of the market created, and Muhammad-Sukki et al (2013) strongly argue for the development of supporting policies based on long-term perspectives on planning for the integration of DG systems, detailing how they will meet consumer needs and ensure benefits are realised for all.

The use of the generous FiT in Italy had similar unintended consequences. As mentioned earlier, the government aimed to facilitate development and growth in the Italian solar PV market. Linked to this objective are aims to decrease carbon emissions and mitigate climate change; however, the targets and systems to monitor progress towards the achievement of these targets are, again, not mentioned. In 2010, the Italian government enabled a generous, uncapped FiT by increasing the general electricity tariffs and accelerated the uptake of solar PV systems until the end of 2012. Antonelli and Desideri (2014) explain that the first, and main, problem emerged when this rapid growth, which was at the financial expense of all electricity consumers (rich and poor), became a significant financial burden. Unfortunately, the realisation came too late, and the financial burden (that currently exceeds the amount required to provide free tertiary education to the population)

will weigh on electricity consumers for the next two or three decades, depending on the pay back scheme chosen.

The government has since introduced tariff caps, and Antonelli and Desideri (2014) assess the effects of the FiT in terms of whether the country's aim of opening a solar PV market was successful. They find that, while there was indeed significant growth, it was not necessarily diverse or sustainable market growth but rather a growth in demand, heavily dependent on government support and subsidy. The second problem that emerged from lack of guidance of market growth was that solar PV systems were not located in areas with greater levels of solar radiation, failing to efficiently take advantage of Italy's solar resources. This is because the wealthier electricity consumers took full advantage of the generous FiT and installed solar PV systems wherever possible, in the north of the country, while participation of the less wealthy population in the south (where there is more sunshine) was limited. This highlights the first problem with the FiT and accompanying policy: it was not based on proper research, nor were objectives of opening a solar PV market aligned with objectives for increased, efficient, RE generation and carbon gas emissions.

A third problem emerged when Antonelli and Desideri (2014) assessed the extent to which the market growth was sustainable. The market is shown to be extremely dependent on government incentives and little has been gained from the rapid growth. Sadly, there was little advancement in solar PV technology, no efficiency improvements in PV panel technology, no local manufacturing of any system components, and only a handful of local inverter suppliers and solar PV system installers emerged (Antonelli & Desideri 2014). Furthermore, there is no mention of consumer consultation or social engagement processes done to include the general public in the design of objectives and mechanisms, creating very reactive policy and market environments. "A balanced incentivisation among RE sources should be promoted to avoid privileging too much one solution among all possible ones", and policy aims and objectives should be aligned to create more sustainable markets, according to Antonelli and Desideri (2014: 593), who also show that many

countries in Europe, including Germany and the UK have experienced several challenges when simply adding a FiT without a coherent, integrated plan for how the mechanism will facilitate the realisation of potential benefits of DG systems.

Australia has both Federal and State levels of government and both support the uptake of solar PV for many reasons. These include: (i) recognition of growing support for strategies to mitigate environmental concerns and (ii) the recognition that support for distributed generation is rising and government needs to be proactive about developing policy to serve public interest and to maintain grid stability (Mountain & Szuster 2015).

Outhred and Retnanestri (2015: 123) list the package of incentives and guidelines for the uptake of rooftop PV (embedded and stand alone systems mostly at residential scale) offered by the Australian government and these include:

- Green electricity schemes (green electricity certificates),
- RE portfolio standards,
- Investment funds,
- A generous FiT,
- Net metering,
- Green Mortgages, and
- Sustainable building requirements.

Furthermore, Mountain & Szuster (2015) explain the drivers for rooftop PV include high electricity prices (of grid supplied electricity) and the fact that 20% of the electorate own rooftop PV systems at residential scale because they saw investment opportunities, wanted to reduce their electricity costs and to mitigate their personal environmental concerns. In the past, politicians have therefore aimed to design attractive SSEG PV policies and incentives to secure voters. This could be encouraged in South Africa by organisations interested in lobbying government to develop more proactive SSEG PV policy however, given the South African socio-

economic context, this may be challenging, as SSEG PV and having the luxury to “care” about the environment is simply unaffordable for the majority of the South African population.

In Australia, Mountain & Szuster (2015) also explain that research into how widespread increases in SSEG PV uptake could reduce the wholesale price of grid supplied electricity is being conducted, as is research into how to maintain grid stability with increased feed in, while Outhred & Retnanestri (2015) highlight the differences in the effects of culture and paradigm on whether or not investment in SSEG PV is prioritised. The conclusion of both articles is that while Australia has enjoyed some success in increasing their SSEG PV uptake within their context, more research is required to improve the deployment and implementation of the technology and to harness, and realise, the various potential benefits it has.

These case studies raise issues of complexity around the design and implementation of financial incentives for the uptake of expensive, small-scale RE systems. Poor planning, barriers to DG due to the centralised nature of existing electricity systems, a lack of public engagement, and a lack of integrated policies and objectives have contributed to problematic consequences of FiT strategies for the uptake of solar PV systems and of facilitating market growth in this sector. Furthermore, if the challenges to the use of profit driven, financial incentives are so extreme in European countries, where electricity consumers are generally more able to participate and finance such schemes than in developing countries, why is there the assumption that this type of incentivisation, without the accompanying integrated policies, targets and objectives, could work in a developing country, such as South Africa? In the following section, I discuss the interesting, holistic approaches to DG from Brazil, Peru and Costa Rica to that show the merits and challenges involved in this type of approach as well as to discuss the important role of public engagement further.

iv. South and Central America

This discussion now returns to developing country contexts because these countries provide more creative approaches towards DG system implementation by proactively engaging with and managing the social, environmental and economic challenges to DG implementation. If ignored, these challenges pose significant barriers to successful uptake or implementation of DG. The challenges to energy and sustainable development in Central and South America are similar to those experienced in Africa: expanding electricity access to rural areas, meeting increasing electricity demand, and ensuring that these objectives are met in socially and environmentally ethical ways, promoting the achievement of sustainable development goals. Geographical challenges to electricity access are also prominent in the Central and South American contexts, particularly in the Andean areas of Peru, limiting the potential grid access in the long term and prioritising the development and implementation of localised DG projects using local resources. This section analyses two DG projects implemented, one each in Peru and Brazil, and provides an overview of the approach to DG taken in Costa Rica – a developing country that seems to have found a sustainable and effective way of avoiding and managing challenges relating to the uptake of DG systems.

Introduction (general information):

What drives the uptake of DG systems in different South and Central American countries and how are DG technologies selected?

Domenech et al (2014) describe the design and implementation of DG applications in Cajamarca, an Andean village located in rural Peru. The project was part of a larger, government initiative in partnership with NGOs such as Practical Action

(PA), Engineering Without Borders (from Spain) and Green Empowerment (GE). The main aims of this initiative were to provide access to electricity from RE resources to promote social and economic development in rural areas, and included the installation of small-scale solar PV systems (95 W for the healthcare centre and two restaurants, as well as 39 stand-alone solar home systems for households and two shops), one small-scale hydro system (to provide electricity to the nearby school), and two 1200 W wind turbines for the remaining households (Domenech et al 2014).

It is not clear, from this literature, what ownership model was used, however, it is clear that the NGOs, particularly PA, remained important stakeholders because they would assist with maintenance and follow-up research (Lillo et al 2015). Lillo et al (2015) take a 'human development' (HD) approach to the assessment of ownership models used in five DG projects in Peru (including the Cajamarca project Domenech et al (2014) describe) and provide a comprehensive discussion on the benefits and drawbacks of each type of ownership model. They show that the most successful projects are usually those that are initiated and owned by the local community, while the second most successful are designed based on information gained from consumer consultation. Wolsink (2012) supports and further argues for this idea that DG should be considered as being embedded in social, political and economic (as well as technical) systems and articulation, with all these system types requiring integrated planning. This case study was selected to further investigate the importance of the role of consumer consultation.

The Brazilian government is committed to supporting development of decentralised generation systems. This case study analyses the extent to which enabling embedded solar PV generation in urban, residential and commercial sectors is affordable with the suggested net-metering tariff from government. This is in order to encourage the utilisation of the country's substantial solar resources (2400 kW/h/m²), because, by 2014, only 4.5 MWp solar PV capacity had been installed (Holderman et al 2014). The aim of the net-metering scheme is to promote a savings

incentive rather than a profit incentive and enjoys much policy support. Brazil's net-metering tariff would be available on each of the country's 63 different distribution systems that are regulated by the national regulator (ANEEL). Holderman et al (2014) model the viability of solar PV systems on all 63 distribution systems.

The case study on Costa Rica is unique because the issue of DG is raised from a different perspective. All the cases discussed thus far have engaged with the topic of DG from different angles. These include from a developmental perspective (discussions relating to the design and implementation of off-grid community DG projects), a technical perspective (where the efficiency of energy and electricity generation and distribution is the primary focus), and a financial perspective (where the discussion is on the effectiveness of FiT, net-metering schemes or service fees). The Costa Rica case study, however, represents a radically different perspective of electricity system design, where, unlike in any of the other cases previously discussed, the nation's electricity utility, the Costa Rican Institute of Electricity (ICE), has "...political and financial autonomy..." (Wilde-Ramsing & Potter 2008: 71). The ICE puts its own targets and monitoring systems in place, and aligns itself with national goals for the uptake of RE. The publically-owned yet not-for-profit utility designs and manages the planning and implementation of DG projects, reducing opportunities for the corruption between government and the utility, as well as reducing the potentially negative effects that a lack of political will or the uncertainty stemming from short-term planning (and short terms of office) can have on long-term policy design. These negative effects are more evident in other countries such as South Africa and Nigeria (Mohammad et al 2013; Wilde-Ramsing & Potter 2008).

Implementation methods and analysis:

What enabling mechanisms were used and to what extent were these considered successful by the authors? To what extent are these projects considered sustainable development projects?

In Cajamarca, Peru, the Peruvian government and NGOs (such as PA) raised funding for the purchase and installation of DG technology systems. The systems were designed after an extensive consumer consultation process to determine community needs and ability to pay for electricity consumed (Domenech et al 2014). This, in addition to a daily demand assessment, was carried out to ensure that community members' needs were met in an affordable way and that expectations were fulfilled by the technology systems installed. Domenech et al (2014) also strongly argue for the importance of identifying and meeting the needs of rural women and children in communities (as their needs may differ to rural men), and in order to ensure maximum benefit is provided. Two years following the implementation of the project, an assessment was conducted to assess the extent to which the project can be considered sustainable. While there were some complaints regarding the intermittency of the technology and the fact that some users would have preferred to be connected to one of the other DG systems due to inconsiderate electricity use of others in their mini grid system, PA was able to manage these problems by installing four new PV panels for additional capacity. Training programmes were also administered to ensure more considerate and responsible consumption habits among community members.

Domenech et al (2014) and Lillo et al (2015) both consider the project to have been an overall success. However, both sets of authors also agree that there is room for improvement. Previously, I mentioned that one of the primary objectives, in Peru, of encouraging DG system uptake was to enable rural development, particularly the development of small businesses. From their analysis, Lillo et al (2015) conclude that this was not as successful as they would have hoped because, without an investigation into the skills required in the community, training programmes for technical skill development are not appropriately designed. This is because, in this case, developers assumed what the training needs were and provided extensive technical training for the operation and maintenance of DG technology. This proved problematic because, in a rural area like this, there is little demand for such skills

beyond the one DG project installed. Second, Lillo et al (2015) point out that providing electricity does not simply translate to increases in microenterprises or local business because the developer cannot assume that rural people have the skills necessary to use electricity available to start microenterprises. Thus, Lillo et al (2015) emphasise that more diverse training is required to improve the sustainability potential for DG projects and to ensure benefits are realised and objectives are successfully completed.

From their financial analysis, Holderman et al (2014: 616) find that even with the net-metering scheme, embedded solar PV for residential and commercial sectors are not viable, on any of the 63 distribution systems, unless "...the specific investment costs could be reduced by 10% and the discount rate could be reduced to 5% in the residential sector...". Holderman et al (2014: 616) also argue that "...if a 20% reduction of the specific investment costs and a 5% discount rate were possible, photovoltaic systems would be economically viable, or at the threshold of economic viability, in more than 40% of all Brazilian distribution networks...". The savings incentive therefore needs more support (in addition to a net-metering tariff) in order to promote the uptake of embedded solar PV. Holderman et al (2014) fail to provide more suggestions for different kinds of measures that can be taken to facilitate the reduction of capital costs and discount rates ,or, for how to otherwise support the net-metering tariff. In addition, Holderman et al (2014) do not mention any government or stakeholder targets to guide the uptake of embedded solar PV systems. Furthermore, there are no signs indicating the consideration of consumer consultation or social engagement processes to investigate community needs and inform the design of alternative support mechanisms. In cases like this, as with the cases involving the FiT, it is clear that a more holistic approach is required (Deshmukh et al 2010).

Costa Rica is an interesting case. The country does not have fossil fuel reserves nor is it overly reliant on large-scale hydro, as Brazil is. However, by 2002, the country managed to rank third in the world (after sparsely populated, developed countries,

Iceland and Norway) for the amount of RE used per capita of GDP (Wilde-Ramsing & Potter 2008). This indicates the success of its radically different structure of the national utility and its relationship with the state and the Costa Rican population. The ICE is well equipped, has access to substantial technical, social and financial expertise, and maintains close contact with the public. This is because the ICE's priority is to conduct electricity development in a socially responsible, integrated manner. Wilde-Ramsing & Potter (2008: 70) identify this as the key to the country's success and argue that, using this strategy, "Costa Rica's commitment to renewable sources of energy has withstood the test of time." This case study lends credibility to all the calls made by researchers, policy makers and stakeholders for a holistic approach to designing and promoting the uptake of DG and RE systems in various contexts as well as to calls for explicit paradigm and changes because Costa Rica represents a successful example of both strategies in action (Lillo et al 2013; Muhamad-Sukki et al 2013; Domenech et al 2014; McDermont 2014; Alvial-Palavicino et al 2011; Manfren et al 2011).

While a more detailed analysis of this context is beyond the scope of this paper, I highlight here that much can be learnt from further study of the Costa Rican example. Even though the structures are vastly different from the South African context, Costa Rica can serve as a benchmark for best practice that can guide the aims and work done for DG implementation in developing countries. The aim of this guidance would be to ensure that appropriate levels of creativity and public consultation are included in designs for social, environmental, energy and electricity, as well as infrastructural and economic development.

v. **Discussion**

This section has highlighted a number of approaches towards the concept of DG in 17 countries around the world and has assessed the effectiveness of each. I recognise that this is by no means an exhaustive review of all the approaches

towards DG that exist in the world, however, the selected examples raise important issues, barriers and shortcomings of the various approaches towards and attempts to implement DG projects, as well as provide several suggestions for how each could be improved. Improvements are suggested by the authors of each case in order to ensure that DG project design and implementation methods lead to the achievement of stated goals and objectives, as well as to render the proposed DG solutions more sustainable and able to provide maximum benefit for the maximum number of stakeholders, including the natural environment.

The problematic aspects of the approaches to, and methods of, designing and implementing DG solutions were found to include the following (in no particular order):

- A lack of consumer consultation and public engagement at all stages of design, planning, implementation and follow-up of DG projects that lead to slow and unsustainable market development and system uptake (Antonelli & Desideri 2014; Ondrazek 2013; Deshmukh et al 2010; Lillo et al 2015; Muhammad-Sukki et al 2013)
- Poor integration of different objectives in planning and policy, for example, aligning objectives for social development with objectives for better environmental practice, as well as with objectives for sustainable market development and future grid upgrade and expansion (Antonelli & Desideri 2014; Urpelainen 2014; Ondrazek 2013; Ahamad et al 2015; Han et al 2016; Liu et al 2013).
- A lack of target setting and development of mechanisms to define and monitor progress towards the achievement of objectives as well as poor development of short-term goals and targets from larger long-term goals. For example, many countries have targets for the reduction in carbon emissions and increase in renewable energy generation capacity, but few

countries detail exact plans, with short-term milestones, to guide implementation progress on the ground. All the aspects that DG implementation could benefit or affect are also not always taken into consideration (Ondrazek 2013; Antonelli & Desideri 2014; Muhammad-Sukki et al 2013; Deshmukh et al 2010).

- A lack of proactivity, research and creativity used when DG projects are designed, often resulting in the implementation of DG projects and related training and capacity building programmes that do not meet consumer needs or fall within the bounds of what is affordable to consumers (Lillo et al 2015; Holderman et al 2014; Deshmukh et al 2010; Koh & Lim 2013)
- The development of mistrust amongst consumers and other stakeholders felt towards government and electricity utility when policies have negative consequences or change at short notice in reaction to market or consumer behaviour due to the short-term, reactive approaches taken to policy planning in some cases (Mienaar 2016; Muhammad-Sukki et al 2013; Cherrington et al 2013; Antonelli & Desideri 2014);
- The structure and design of existing electricity infrastructural, social and economic systems that present all sorts of technical, social, political and economic barriers towards the design, implementation and/or uptake of DG technology (Wilder-Ramsing & Potter 2008; Ondrazek 2014; Holderman et al 2014; Koh & Lim 2013; Melheri et al 2013; Han et al 2016; Liu et al 2013).

This analysis also shows that the Costa Rican and Chinese energy and RE development contexts represent the closest examples of the most effective ways to sustainably promote the uptake of RE systems via DG installations. These are discussed in more detail below. My analysis also shows that, despite the highly context specific nature of DG applications and initiatives, there are core similarities

between the seemingly different challenges that present themselves to those working on ensuring the successful uptake of DG systems. Core similarities therefore also emerge between the suggestions and policy recommendations researchers offer on how to improve the implementation processes in each context. Finally, I show that these similarities, when viewed together, essentially point toward the requirement of a more holistic approach taken towards implementation of DG systems.

Many suggestions for how to tackle these challenges and shortcomings have been suggested throughout this literature review and ultimately point to a more holistic way of conceptualising DG planning and development. This discussion now turns to what such an approach could look like.

d. Section 3: A way forward

The discussion above highlights a number of issues that have been raised by researchers around the world and, while the issues appear to differ on the surface, they essentially stem from a lack of consideration of the consumer and their true energy needs. FiTs, for example, have been used to incentivise people in the UK and Italy to buy embedded solar PV systems that they actually don't need because homeowners have access to grid supplied electricity. As a result, the solar PV market is highly dependent on incentives. In countries that need to decrease consumption of electricity generated by fossil fuels, such as China, Costa Rica and Kenya, the uptake of, and commitment to, DG and RE systems have been more successful. The idea therefore emerges that having a consensus on the need could help improve attempts to enable DG in different contexts. Odarno et al's (2015) suggested model (pictured on the following page) offers suggestions on how to

determine collective needs and establish a consensus on strategies to meet those needs.

Odarno et al (2015) provide a useful example of a holistic approach to distributed generation and practical guidelines for perceiving and managing the various aspects of DG development in order to be more proactive in managing the many challenges mentioned above. Essentially, this model relies on the understanding that the ten main aspects one has to consider when planning DG solutions are equally important for improving the chances that the project will be a success. The model that Odarno et al (2015) provide encourages planners and stakeholders to engage with as many of the ten aspects mentioned as possible, and they provide ten questions (each with a number of sub questions) to guide planning processes and that can be used to develop integrated planning methods. The 10 aspects are “the planning process, objectives of DG, target establishment and monitoring, flexibility, ownership approaches, policy and regulation, investment financing, technical and institutional capacity, consumer engagement, and environmental and social consideration” (Odarno 2015: 5).

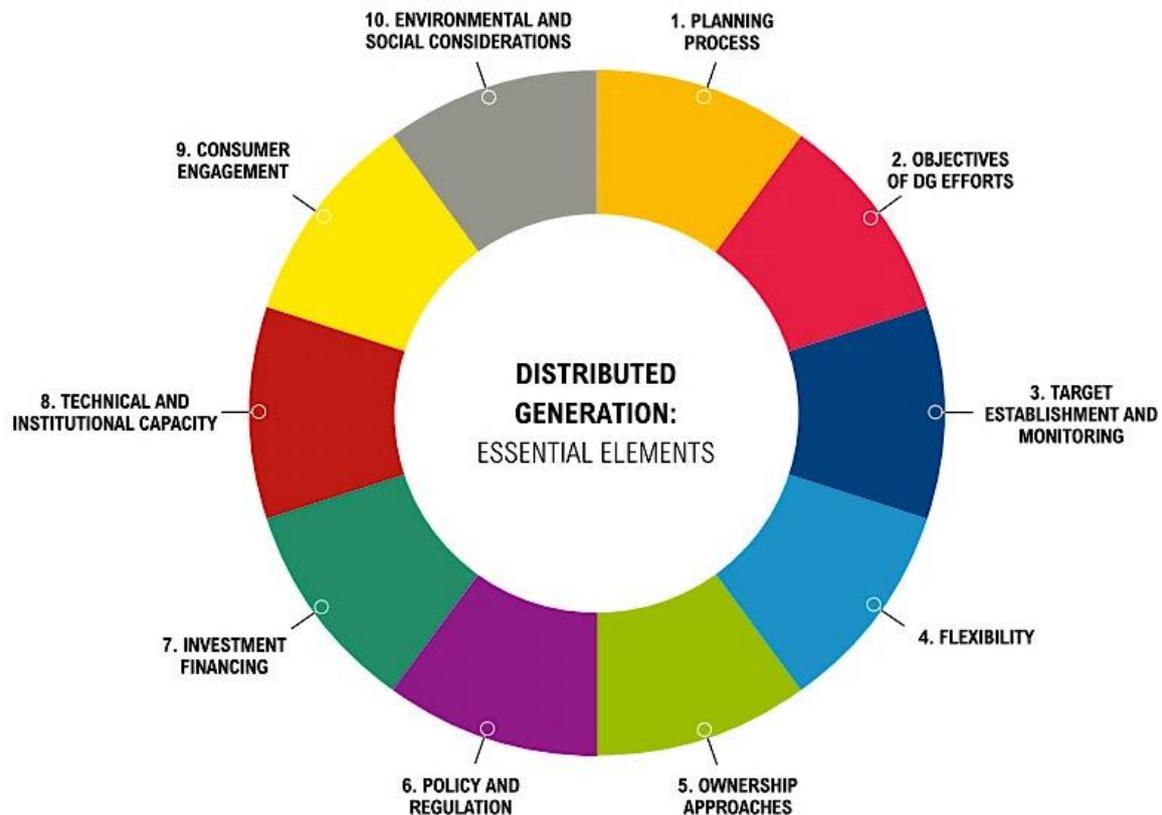


Figure 11: The ‘essential elements’ of DG for a more holistic approach to designing uptake strategies (Source: Odarno, L.; Martin, S. & Anger, C., 2015)

This approach emphasises teamwork between policy makers and other stakeholders in the early planning stages of the project to establish long-term and short-term goals that will eventually reveal and inform the social and environmental objectives that the DG system technology is set to achieve. Consumer engagement is the next priority because, not only does the suggested technological solution need to meet electricity-related needs as well as any social and environmental objectives, it also needs to be affordable to the potential consumer. The main objectives of considering other aspects such as the ownership model, progress monitoring processes, financial input and capacity building are included to ensure that the DG

project is self-sufficient and sustainable over the long term, ensuring it does not remain a financial or administrative burden on the local government involved (Odarno et al 2015).

While Odarno et al (2015) mention that environmental and social aspects should be considered and that these are as important as any of the other nine topics mentioned above, I would suggest that these aspects be prioritised from the beginning (planning stages) and integrated into the collective definitions of the 'needs' laid down in the planning stages. This is because, in cases where fairly holistic approaches have been taken, there are still ways in which short cuts can be taken around having to ensure proper realisation of local social and environmental benefits, as Mienaar (2016) pointed out in the case of South Africa's REIPPP programme.

Such participatory processes are often considered problematic because they can be time and resource intensive; however, the long-term benefits potentially far outweigh the short-term costs. It has already been shown that approaches that fail to take the many different aspects of an essentially multifaceted project into consideration, also fail to successfully develop sustainable and independent DG solutions, and those that do (to some extent at least) have enjoyed more success.

e. Conclusion

This literature review has gathered and discussed a number of approaches towards energy and electricity development approaches that 17 different countries have taken in response to climate change and the various development challenges relevant to each context. The review has revealed three main points.

The first is that each country has faced a number of challenges to each approach taken and that, thus far, there is no example of a completely fail-safe method for

introducing DG with RE in contexts otherwise dominated by centralised electricity generation systems.

The second is that, even though these challenges differ from context to context, when considered together, a common thread is evident throughout. This thread, as discussed above, is that the needs of the consumer and other stakeholders are not collectively determined and therefore any attempts at planning DG initiatives are done so from either the perspective of the policy maker or donor only, and often only to provide financial incentives to potential consumers to encourage them to invest in systems that they actually do not need. This results in unsustainable market development at best and the failure to encourage the uptake of the DG system at worst.

The third, and most interesting, point that emerged is that DG and RE commitment and uptake was most successful in countries whose governments had taken proactive, holistic approaches to ensuring that needs were determined and met. The Chinese and Costa Rican governments have each taken different approaches for how DG and RE development is encouraged. On the one hand, the Chinese government has almost complete control over how development is planned and is able to determine needs and dictate solutions that will be carried out to varying degrees of success. The Costa Rican government, by contrast, has separated itself from the electricity and energy planning processes, leaving this to an independent organisation, the ICE, who is able to keep focus of RE development initiatives without the potential short-term disruptions caused by any political changes. Among the chosen case studies, the ones in which stakeholders and policy makers struggled the most to encourage the sustainable uptake of DG systems (the UK, Italy, Tanzania, and India, to name a few), were those whose governments did not display strong enough commitment to the idea of DG and RE uptake and therefore failed to take holistic or committed approaches. Instead, many simply enabled a financial incentive that proved unsustainable and failed to harness the need for a healthy planet for human survival to create collective need amongst potential consumers.

Finally, I have offered Odarno et al's (2015) model as a way for policy makers and participants to develop collective understandings and perceptions of why DG systems may be useful in their relevant contexts. The guiding questions provide an idea of how they can go about organising such initiatives in a proactive, holistic way that acknowledges the multifaceted nature of these initiatives. This model was chosen because it speaks to ways of managing many of the issues raised by the different authors of each case study and provides the holistic approach that many of them call for. The following two chapters provide an investigation into small-scale embedded generation (a type of DG) in Stellenbosch, South Africa, to determine the specific challenges to the initiatives suggested in this context, and provide an example of the extent to which Odarno et al's (2015) model could be used to manage some of these challenges.

4. Chapter 4 – The Case Study

a. Introduction

In this chapter, the Stellenbosch municipality case study is described and discussed. Stellenbosch Municipality recently proposed an SSEG tariff to regulate PV installations. The aim of this case study is to provide insight into consumer opinion towards the idea of installing embedded, rooftop solar PV at residential scale in Stellenbosch with the accompanying FiT. The case study consists of a focus group, surveys and interviews.

The focus group was conducted with ten participants who attended in their capacity as homeowners in Stellenbosch to share information on the FiT and to discuss the various practical and financial implications involved in investing and using SSEG PV systems. The overall aim was to determine what their opinions are towards the FiT and the idea of SSEG PV and RE uptake in general. The short survey (that consisted of two questionnaires) was conducted with the same ten participants; the first questionnaire (Questionnaire 1) was completed by participants before the focus group discussion, and the second (Questionnaire 2) was given to participants to complete after the focus group discussion. These were conducted to determine whether there would be any changes in the answers given before and after the focus group discussion (that included an information dissemination session on the implications of investing in PV). The interviews were conducted with policy makers from the Stellenbosch Municipality, the CCT Municipality and the Western Cape provincial government. These were conducted to gain insight into the municipalities' perspectives and pressures, and gain a more detailed understanding of the broader case study context. Section 1 describes the case study and its context, while section 2 reveals the findings from the focus group discussion. The chapter ends off with key findings and conclusions.

b. Section 1 : The broader case context

The case is contextualised with reference to the broader socio-economic and political system that the Stellenbosch Municipality (and Stellenbosch Town) form part of. Insight is also provided into the approach to DG taken by the Western Cape Provincial Government with the Energy Game Changer project and other provincial level actors in the system, such as GreenCape, the Centre for Renewable and Sustainable Energy Studies (CRSES) at Stellenbosch University, and key actors at municipal level, such as the Head of Green Energy at the CCT as well as the Head of Electricity at Stellenbosch Municipality.

I have already provided an analysis of the broader context of the South African electricity system and its policies, actors and many challenges (Krupa & Burch 2011; Büscher 2009; Heddon 2015; Baker et al 2014). That analysis highlighted the policy gap regarding the development of DG at residential scale and the plight of municipalities as they struggle to negotiate the challenges of regulating the increasing uptake of SSEG systems without guidance from national government.

Despite the challenges, many municipalities are beginning to engage with the idea of enabling feedback into their municipal grids from embedded solar PV system owners (at residential scale). Stellenbosch Municipality has recently joined this trend in an attempt to regulate grid connection and feed-in because of safety concerns related to illegal feed-in and because there is the widespread belief that municipal revenue streams are threatened by this practice (Reinecke et al 2013).

This section provided more detail to contextualise the Stellenbosch case study, both in terms of its relevance to existing knowledge and existing debates, as well as in terms of the geographic, social, political, technical and research contexts that are relevant to the nature and details of the case.

i. Existing social research and debates on DG in the South African context

DG (or SSEG) is a relatively new development in South Africa, and, while there has been much technical research done on embedded generation (locally and globally), there has been little social research done on the topic in South Africa, and none in Stellenbosch. I have found that there are, however, two main bodies of social research that engage with consumer feedback on related (and similar) topics of green energy and embedded solar PV. These bodies of research can be represented by one or two key studies each that have been conducted in the South African context.

The first body of social research includes a telephonic survey of 405 participants in the Western Cape Peninsula that was conducted to determine whether or not participants would willingly, and voluntarily, pay a premium price for green electricity to help minimise the damaging effects of carbon emissions (from coal-fired power stations) on the environment and to help finance RE projects (Oliver 2009; Oliver et al 2011).

Kritzinger (2009) studied the willingness to pay for green electricity in the Cape Peninsula, building on the surveys in Oliver's (2009) telephonic survey, and found that, while there was a high level of concern for the environment, future behaviour (actually participating in a voluntary programme to pay a premium for green electricity) could not be linked to (or predicted by) current energy efficiency behaviour.

Kritzinger (2014) conduct a similar study on the willingness to pay for green electricity among businesses in eThekweni. It was found that there was an unwillingness to pay a premium for green electricity was prevalent.

Although this body of research does not directly relate to the current study, it is useful to note that environmental concern presents a significant motivation factor for residents to consider spending more money on electricity. This, however, is less

of a motivator for businesses in the context described. It is, however, worth noting that Kritzinger's (2014) study emphasises increased communication and engagement with potential consumers to provide information on how their contributions would benefit the environment to increase the chances of success for the intervention, as most participants remained unconvinced that their efforts would actually help.

The second body of research on the topic includes a study that was conducted by the Energy Security Game Changer, a priority programme of the Western Cape Government, to ensure the availability of enough power for low carbon growth in the province that is sustainable. This research was conducted in the absence of existing literature on the topic in the South African context (Wicht 2016). Its findings are directly relevant to this study, because the basis of the Game Changers' research was the recognition that an understanding consumer behaviour and attitude is necessary when designing campaigns and programmes to facilitate market development for RE technologies (Mthente 2016: 6). The results of this research are yet to be published, however its findings echo Clark's (2000) findings that further emphasis should be placed on the importance of demand-side management in South Africa and that energy efficiency measures should not be forgotten in the face of RE uptake, because they are essential to ensuring savings are made with the use of RE systems, solar PV systems in particular.

The research described above is hugely significant to this study because, although the Energy Game Changer Project could use this market research to inform the development of communications campaigns as well as other marketing and policy decisions, it also highlights the value of consumer consultation. They also show that consumer consultation proves fundamental to the development of alternative approaches towards distributed generation uptake.

When I first began this research project, I too progressed towards the idea that more market research was required in order to determine whether homeowners in Stellenbosch would install solar PV systems if they could feed excess electricity

back to the municipal grid. I too suspected that more rigorous awareness and marketing campaigns were required because, strangely, areas such as Drakenstein Municipality (neighbouring Stellenbosch Municipality) that had already enabled a FiT, had not seen a dramatic increase in the uptake of embedded solar PV systems (as confirmed by Ms Wicht 2016). I changed trajectory, however, because a number of things led me to question the logic behind the FiT scheme, and I thought that, instead of creating more market campaigns, it may be useful to find out what people think of the idea for themselves because this may provide insight into why they have chosen not to participate.

I first began to question the logic of what I was doing with a market research-based study after a meeting with Associate Professor Charlene Gerber of Marketing Management and Research Methodology at the University of Stellenbosch Business School. At first, following her advice, I set about designing a survey based on the theory called the ABC model of attitude. However, as I have explained previously (in chapters 1 and 2), I realised that it was a flawed endeavour (Personal journal 2016). This model was based on theory that held that people's attitudes tend to influence their behaviour and, by uncovering the attitude towards a new FiT for Stellenbosch, I could gain a sense of how homeowners in Stellenbosch may respond to the opportunity. Associate Professor Gerber explained how I could design a survey to measure the attitude of a participant towards the idea of investing in a solar PV system and whether this attitude might change when a FiT was provided. However, I encountered many practical challenges along the way.

For many months, I was at quite a loss for how to proceed, until I attended two key meetings that helped me understand what I had been trying to do and how else it was not a useful line of enquiry.

The first of the two meetings that represented a turning point in my research were with representatives of SALGA (including the Executive Director of Municipal Infrastructure and Services, Ms Jean de la Harpe, and the Renewable Energy Technical Advisor, Ms Aurelie Ferry). The second was a round table discussion

held at an organisation called One World. The round table discussion was well attended by various players in the South African RE space, including Sustainable Energy Africa (SEA), Solar PV suppliers, and various NGO groups.

From these meetings, I realised that, similarly to debates on RE development at a national level, the discussion around DG at municipal level in South Africa tends to occur from two primary departure points: the market development perspective and social development perspective. Proponents of the market angle at the round table discussion were biased towards policies that facilitated the development of the solar PV market and were perceived as insensitive towards the plight of those who could not afford to participate by those from the social perspective. The proponents for the social development angle, on the other hand, were biased towards promoting the uptake of RE initiatives that provide low carbon energy and electricity access to those currently without access. However, these social initiatives are considered unviable (from a market perspective) unless donor funding is available (Personal journal and meeting notes 2016).

The debate between proponents of these two positions got quite heated at times and it made me realise that there were two main reasons for why I had struggled with the design of the survey and with potentially having confidence in the kind of data I would gain from it.

First, I had my doubts about the extent to which attempts to ‘predict’ market behaviour was possible to any degree of accuracy, when so many variables (such as levels of consumer knowledge and behaviour, perceptions of consumer needs, consumer values and beliefs towards RE, and the seemingly infinite number of ways to design and use solar PV systems) were at play. These doubts were confirmed when I finally came across Shove’s (2010) article on the limitations of the ABC model in terms of providing information to inform policy decisions for sustainability.

Second, I realised that my survey would contribute to, and form part of, the neoliberal narrative of how DG development should occur. I found this

uncomfortable, because my views on development resonate more with the social development perspective. The nail in the coffin of this line of inquiry was that further research revealed the ABC model to be rather out-dated and problematic, and I eventually abandoned this line of enquiry (Shove 2010). I also now recognise that the overall debate, while relevant, has no resolution in sight and thus I redirected my attention towards exploring the details of the situation, in search of a way to use feedback from potential SSEG PV consumers in an alternative and perhaps more useful way.

This short review of existing research and debate shows that some social studies have been conducted, primarily, as market research to gain insight into consumer behaviour and provide recommendations for policy and awareness campaigns. It also shows that none of the existing research findings are used to inform alternative approaches to the planning and design of RE solutions or encourage further consumer engagement to determine and meet electricity, energy, environment and social needs, and that there is also a gap in perspective in this regard.

ii. Specific case context: Stellenbosch Municipality and Stellenbosch town

This section describes the geographical, social, political and technical contexts from which this study emerged and provides the reader with insight into the many ways in which these contexts influenced the shape and nature of this research.

1. Geographical context

Stellenbosch Municipality, located in Stellenbosch, Western Cape (see map below), aims to be one of the greenest municipalities in the Western Cape (Stellenbosch Municipality 2016b). The municipality area covers the Stellenbosch Valley in the Western Cape Province, roughly 60km from Cape Town city centre, and covers 900km² of ground. It includes the towns of Stellenbosch, Franschoek and Pniel (Statistics South Africa 2016; Stellenbosch Municipality 2012). The Stellenbosch

population is at 155 733 according to the census conducted in 2011. Because this area includes four nature reserves and is surrounded by mountains and vineyards, Stellenbosch is also world renowned for its scenery and closeness to nature, which plays a role in the future imaginings of the town's development (Statistics South Africa 2016; Stellenbosch Municipality 2012).



Figure 12: The Western Cape Province in South Africa (Source: BSA., 2012)

Below is a more detailed map showing the location of the Stellenbosch Municipality in the Western Cape.

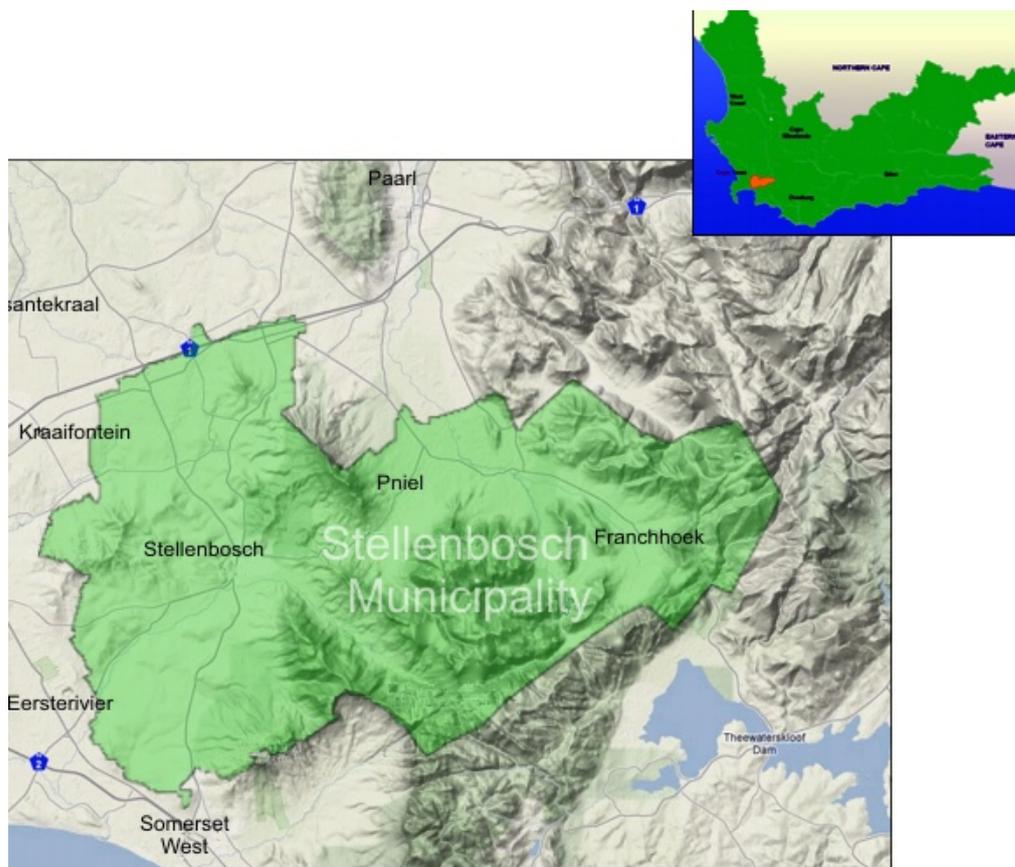


Figure 13: Stellenbosch Municipality in the Western Cape Province (Source: Western Cape Government, 2016 b)

The municipality, whose vision is of being the “innovation capital of South Africa” and aim “is to deliver cost-effective services that will provide the most enabling environment for civil and corporate citizens”, has recently released the Self Generation of Electricity and Feedback into the Stellenbosch Municipal Grid Policy 2015/2016 (Stellenbosch Municipality 2016b; Stellenbosch Municipality 2016a). This provides background and insight into the physical, geographical context from which this case study emerged and within which it was conducted. It also highlights the values that are held by the Stellenbosch Municipality towards green, innovative development, and supplies some reasons behind the policy change to enable embedded solar PV generation.

This case study focuses on the feedback gained from a group of ten residents of Stellenbosch town, who are part of the Jonkershoek Residents' Association (JRA) and who live in the areas located in the Jonkershoek Valley. This is one of Stellenbosch's most affluent residential areas. This area was included in another recent MPhil research project that investigated the technical and financial aspects of embedded generation. The MPhil study referred to above (Korsten, 2016) concluded that, even if the maximum number of households installed embedded solar PV systems, the effect on the municipal finances would be less than expected. This research is discussed in more detail further on; however, it is also relevant here because the results provide insight into whether the maximum number of homeowners is likely to accept the offered FiT and whether or not they express enthusiasm towards the idea of embedded generation. This response will give the municipality a sense of the extent to which their electricity sales revenue will be affected. The residents from the JRA expressed interest in the current study and agreed to my request to invite participants, from their mailing list, to join the focus group for this study.

2. Social Context

There are many actors and stakeholders involved in the research and planning for the future infrastructure development and resource management processes for the municipality. The key stakeholders relevant to this study include the Stellenbosch Municipality itself (including the Head of Electricity, Mr Jan Coetzee, and the IIC), the Sustainability Institute and Stellenbosch University (promoting the involvement of students and their research project supervisors), the CRSES, GreenCape, and, of course, the homeowners in the Stellenbosch town. Much research in the form of masters level (MPhil) projects has been generated as a result of this interaction. I draw on some of these studies conducted by my colleagues whenever relevant, because this study is also a product of interactions with them and did not evolve in a vacuum.

The IIC assisted with the drafting of the Spatial Development Framework (SDF), subsequently released by Stellenbosch Municipality. The document aims to address the development challenges of the town and promotes a Transport Oriented Integrated Development model of future development. It also attempts to integrate planning from various sectors such as water, waste, electricity, infrastructure and transport (IIC 2014). This document also aimed to address the issues presented by the conservative, business-as-usual model of development employed by the municipality to date. The need for change emerges because the business-as-usual model serves to preserve the problematic idea of “authenticity”, particularly that of the Stellenbosch town. This is problematic because a fundamental feature of the town’s “authenticity” is its strong resemblance to the racially and socio-economically segregated town planning of the Apartheid era (Mafame 2017). Development policies that serve to promote and protect this level of inequality are therefore problematic on a number of levels because they promote further social and economic inequality, and need to change if sustainable development is to be a priority. The IIC has, however, experienced significant challenges and since the release of the SDF, all meetings have been postponed indefinitely, leaving researchers and planners alike in the lurch (Swilling 2014, personal communication, 6 October). These events have played a key role in developing the research context for this study and other studies, because this study was initially designed to provide information to decision makers in the Electricity Working Group of the IIC on the development options for Stellenbosch’s electricity system. This provides the social context from which this study emerged.

The Stellenbosch population by race is depicted in the pie chart below. According to the previous census, conducted in 2011, unemployment is at 15.2 % and wealth is distributed unevenly across the population. In 2011, Over 20% of the population had no household income, while 8.5% of the population enjoyed increased average of household income figures of R307 600 per month and above (see graph below).

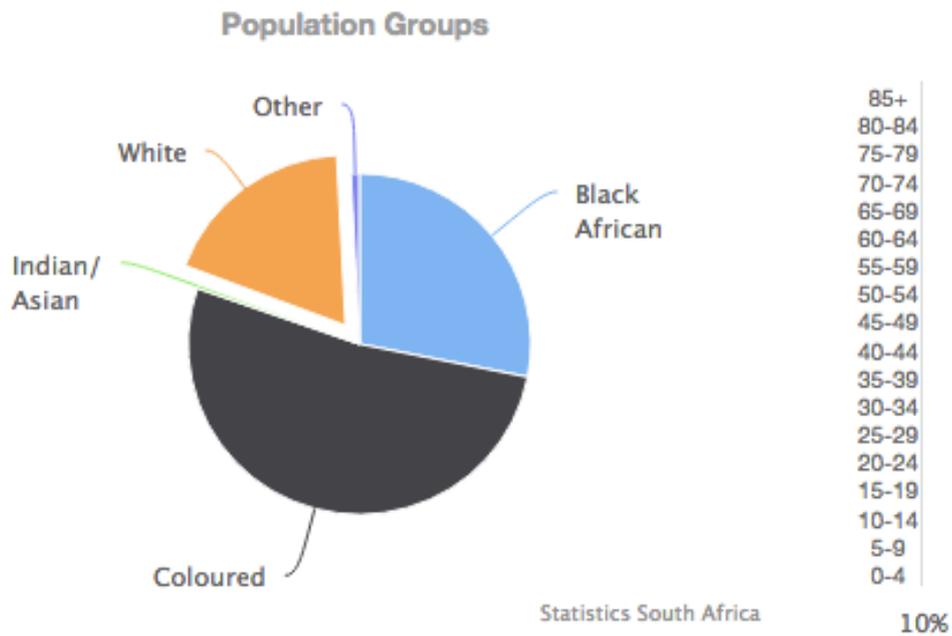


Figure 14: Stellenbosch population by race. Source: Statistics South Africa. 2011. Stellenbosch, people. [Accessed online: 6/02/2017]: http://www.statssa.gov.za/?page_id=993&id=stellenbosch-municipality

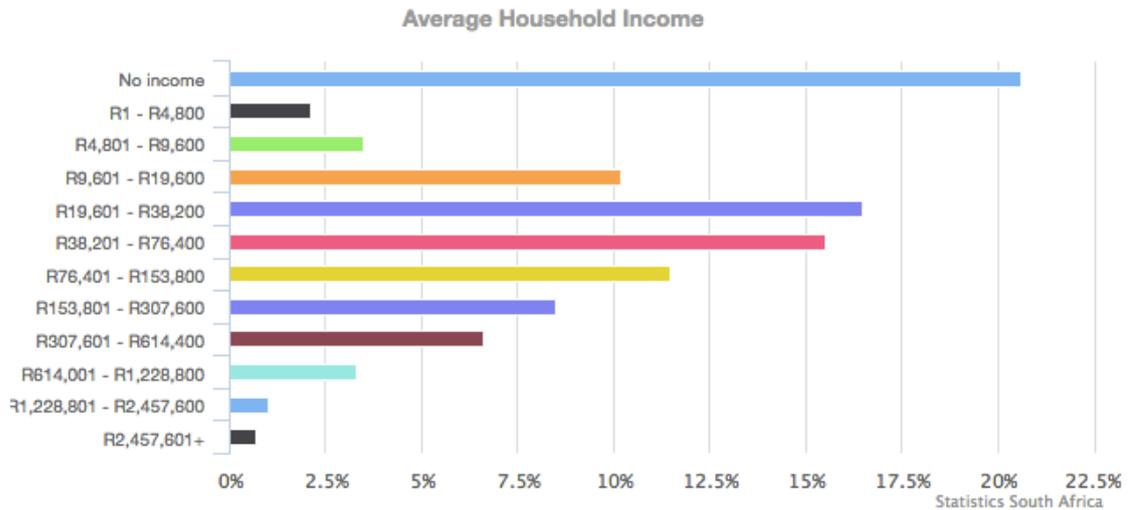


Figure 15: Average household income in Stellenbosch according to data gathered in the 2011 census. Source: Statistics South Africa. 2011. Stellenbosch, economy. [Accessed online: 6/02/2017]: http://www.statssa.gov.za/?page_id=993&id=stellenbosch-municipality

This is important information because it highlights the need for a more inclusive development to promote socio-economic equality, necessary for sustainable development.

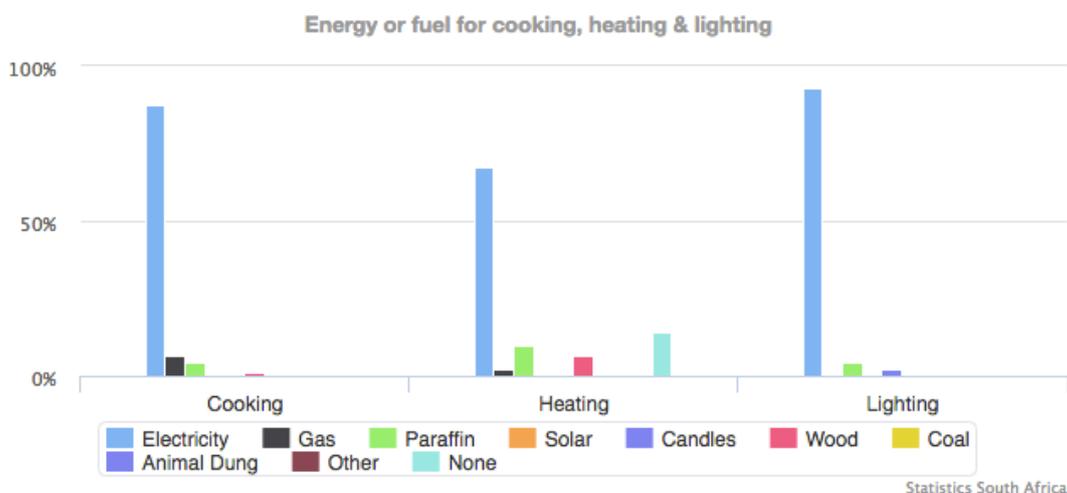


Figure 16: Energy usage for heating, cooking and lighting in Stellenbosch. Heavy reliance on electricity can be attributed to agricultural and industrial activity in the town but also includes residential electricity and energy consumption. Source: Statistics South Africa. 2011. Stellenbosch, living conditions. [Accessed online: 06/02/2017]: http://www.statssa.gov.za/?page_id=993&id=stellenbosch-municipality

The graph above also shows the heavy reliance of the population on electricity as a source of fuel for heating, cooking and lighting. This highlights a need for secure and sustainable sources of electricity to meet the populations' demand. There is therefore potential space for the design of inclusive development and renewable energy development in the area.

3. Political context

The Self Generation of Electricity and Feedback into the Stellenbosch Municipal Grid Policy 2015/2016 is the product of a discussion between the CRSES, GreenCape and the municipality, and was also one of the Electricity Working Group's initiatives.

Following the suspension of IIC meetings, the Stellenbosch Municipal council approved this policy and a draft was released in May 2016 for discussion (Stellenbosch Municipality 2016a). The policy and tariff were modelled on those of the CCT Municipality. The CCT is therefore a point of reference, or an example, for other municipalities to copy. The CCT was also one of the first in the province to begin experimenting with pilot projects for residential, embedded solar PV systems,

FiT structures, and technical guidelines. The finer details of the policy and tariff structure are, however, specific to the Stellenbosch context and were developed with the help of GreenCape and the CRSES.

The Energy Game Changer project (positioned at provincial government level) is also aware of- and engages with- Stellenbosch Municipality management. This municipality was also included in the market research on solar PV that I mentioned earlier. The mandate for the Energy Game Changer is to provide support for the facilitation of the uptake of solar PV systems and is interested in how the potential solar PV market in Stellenbosch may respond to the new FiT provided.

National level policies relevant to municipalities and to the potential development of DG include the Local Government Municipal Systems Act no. 32 of 2000 (DCoGTA 2000) and the Local Government Municipal Financial Management Act no. 56 of 2003 (DCoGTA 2003). A full review of these policies and their relevance can be found elsewhere (Brent et al 2012), however I note here that these policies include a layout of the rigid financial models for electricity management at municipal level. While these policies do not prohibit municipalities from generating their own electricity, there are sections that complicate their ability to purchase electricity from other generators, and these present potential barriers to the design and uptake of SSEG (or DG) systems in Stellenbosch and elsewhere. The Electricity Regulations Act (ERA) informs the National Energy Regulator of South Africa (NERSA), and the Department of Energy (DoE) is currently updating the ERA to include the definition of “self-generation” and regulations regarding embedded generation and feed-in (DoE 2006). The update of this act should be out for public comment soon (Cramer 2015).

These are the primary actors that form the group of policy and decision makers relevant to this particular case study. The second group of actors are considered to be the homeowners who participated in the focus group discussion. Their input is

considered of great importance in this study and is discussed in far more detail in section two.

4. Technical context

The technical context of the Stellenbosch electricity system is discussed in the Electricity Master Plan (Stellenbosch Municipality 2006) and in the SDF (Stellenbosch Municipality 2012). Both these documents indicate that the system will struggle to provide electricity to meet increasing demand as the town continues to grow. Maintenance backlogs exist and the Electricity Master Plan (Stellenbosch Municipality 2006) deals only with the budget for future maintenance and grid extension plans, and not with the management of the uptake of RE systems. In a meeting with the Head of Electricity, Mr Jan Coetzee, he showed me the updated Electricity Master Plan, which is soon to be published. This document still (at the time of writing) does not engage with the potential challenges presented by the potential uptake of embedded PV systems in the residential sector (Coetzee 2016).

Furthermore, there are technical limits that cap the amount of feed-in that the grid can manage before it starts to threaten grid stability. This limits the PV market growth, because it potentially caps demand and raises questions as to the extent to which embedded PV can contribute to sustainable development and management of the stated challenges or to the achievement of their stated goal of being the “greenest municipality” (Reinecke et al 2013; Stellenbosch Municipality 2016b).

5. Research Context

I mentioned above that the social context in Stellenbosch encouraged the participation of researchers in order to generate knowledge that could potentially inform policy and decision makers in Stellenbosch.

There are a number of relevant MPhil projects that have emerged from this engagement. An analysis of the IIC process (as an example of integrated development in action) and the rationale for Transport Oriented Development in Stellenbosch can be found in Megan Davis’ (2016) MPhil project entitled “Intermediaries and learning in sustainability-oriented urban transitions: a

transdisciplinary case study from Stellenbosch Municipality”.

Further information and visual representation of the social segregation that exists in Stellenbosch today can be found in Thendo Mafame’s (2017) MPhil research project “Transit oriented development (TOD) as a facilitator for urban development integration: case study: Du Toit station, Stellenbosch”. This is important because it provides a section that deals with the current, systemic divisions in Stellenbosch society that has yet to be addressed.

Finally, Nikki Korsten’s MPhil project, entitled “An investigation into the financial impact of residential embedded generation on local governments in South Africa: A case study into Stellenbosch Municipality”, was significant because it laid the foundations from which the current study was developed.

Korsten (2016) investigated the amount of revenue that the Stellenbosch Municipality could potentially stand to lose if the municipality enabled a FiT for residents to feed their excess electricity back to the municipal grid. She focused her financial analysis on the assumption that the maximum number of households in several affluent neighbourhoods in Stellenbosch (town) that could feed back into the municipal grid (due to technical constraints) would do so. The results show that the effects would not be as dramatic as expected and that a FiT is recommended.

The current study aims to provide some insight into the opinions of participants (homeowners from the affluent Stellenbosch neighbourhoods, specifically those located in the Jonkershoek Valley) towards the FiT. I aim to engage with the idea of whether or not the participants are likely to consider it as an incentive to invest in embedded solar PV systems and why (or why not). This study emerged from discussions that initially formed part of the IIC process, but then diverged somewhat when the IIC meetings were postponed indefinitely. Engaging with existing as well as potential consumers could shed some light on the matter because, to date, the FiT enabled in other municipalities such as Drakenstein, has not yet lead to significant increases in SSEG PV uptake.

For now, the results from the focus group and survey are presented and discussed in terms of the five key themes that emerged from the facilitated discussion.

c. Section 2: Case findings

This section reveals the findings from the focus group discussion and interviews- the original transcripts of which is that is attached as an addendum- and highlights some of the key issues raised by participants and their relevance to this discussion.

i. Focus group and interview findings

This section presents the findings of the focus group interaction and the interviews conducted. The topics and issues that participants raised in the discussion can be organised into five key themes:

1. The participants
2. The differing perspectives on the problem;
3. A clash of objectives;
4. Consumer related feedback;
5. Ethical, environmental and social considerations; and
6. The role and effects of knowledge dissemination.

The voice of the consumer is of primary importance and is presented as clearly as possible through the many quotes taken from the original transcript (verbatim).

The following section provides a discussion of each theme, with extracts from the interview and focus group transcriptions. Data from the questionnaires is also included. Each theme is discussed according to the issue raised, the evidence to support it and the implication of the finding as well as its usefulness to this study. These findings therefore serve to indicate the extent of the knowledge that is

missing and that could be useful to inform future decision-making in this field for the design of more sustainable solutions.

The themes form the framework for the discussion of the results and Odarno et al's (2015) framework described in chapter 3 is shown to be increasingly relevant as a way of understanding the implications of the results.

1. The Participants

In this section I introduce the reader to the participants of this study and reveal the socio-demographic information relevant to the focus group participants including age, gender, household income, and race. A more detailed description of the selection process of participants for the focus group is available in chapter 2 of this study, but I'll repeat here that the participants came from a convenience sample and attended out of personal interest in the issue.

Participants who attended were between 35 and 70 years of age and they all owned their own houses in Stellenbosch. Many of the participants mentioned having children attending schools in the area. This potentially indicates that they have made long-term commitments to living in the area. This is important, considering that PV systems last for at least 20 years. It could also be argued that a PV system will increase the value of the house to some extent, and that homeowners could disassemble and take their PV systems with them, should they decide to move house. However, since this is an emerging market, it is presumed here that a homeowner will only invest in a PV system if they have made a long-term commitment to living in the house.

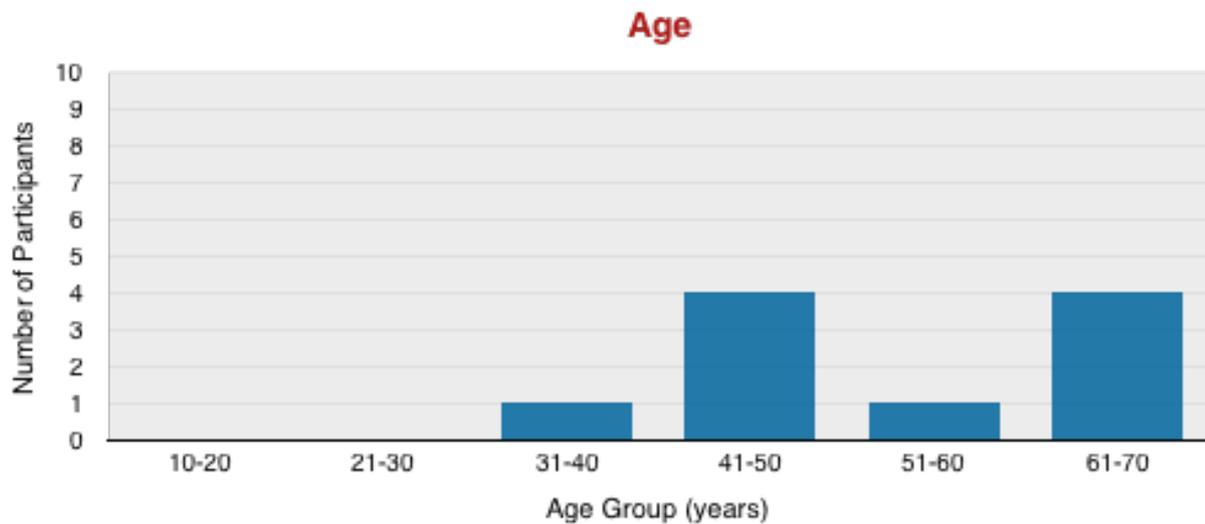


Figure 17: Participants by age.

Figure 14 illustrates the age groups represented by the focus group participants. A future study could explore and compare whether opinions on embedded PV and RE differ according to different age groups, and, therefore whether communication and participation programmes, RE solutions, or planning processes would need to be designed differently for different age groups of electricity consumers.

Only one of the ten participants was a woman. The only other women in the room were the co-facilitator and myself, the researcher.

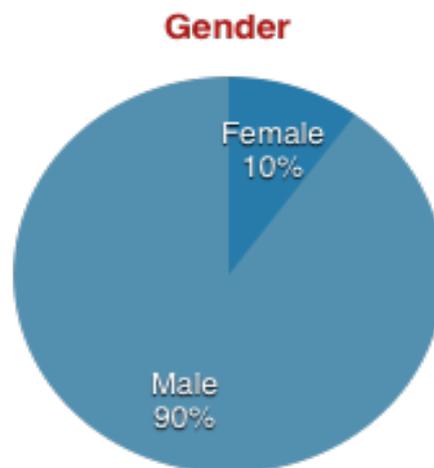


Figure 18: Participants by gender.

Some reasons for the high percentage of male participants emerged in the focus group discussion. However, further research is required to determine why women chose not to attend a discussion of this nature and what their stance would be on electricity and sustainable, RE related issues. Possible reasons for the lack of woman in attendance are raised further on, under the heading: ‘The Involvement of Women’.

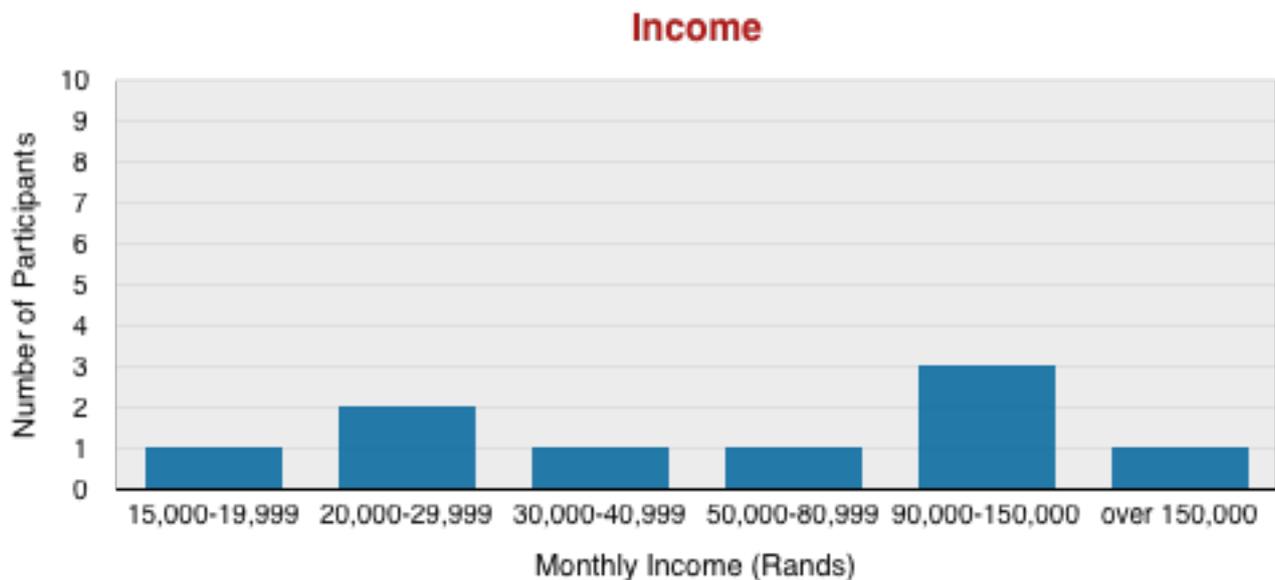


Figure 19: Household income of participants

The bar graph above shows that nine of the ten households could be considered “high income”. One participant elected indicated that he was a pensioner and did not provide an indication of income. Participants primarily fell into LSM groups 7-10.

Table 4: Life Standard Measure (LSM) groups 1-10 with average household income (SAARF, 2012)

	Average Household Income	
	Jun10	Jun11
LSM 1	R1,496	R 1 363
LSM 2	R1,732	R 1 929
LSM 3	R2,052	R 2 258
LSM 4	R2,829	R 3 138
LSM 5	R3,832	R 4 165
LSM 6	R6,398	R 6 322
LSM 7	R10,066	R10 255
LSM 8	R13,698	R 14 014
LSM 9	R18,414	R 19 654
LSM 10	R27,143	R 29 512

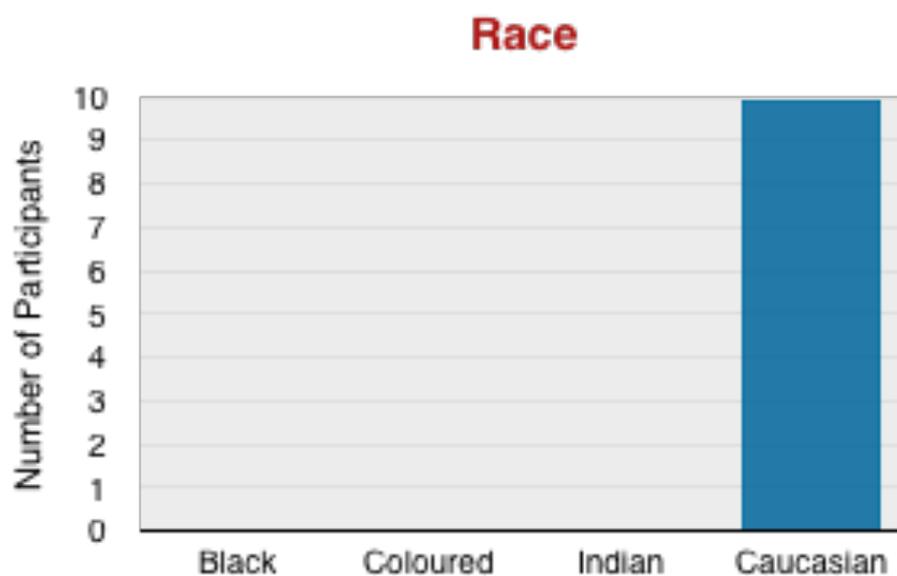


Figure 20: Participants by race.

All the participants were from the racial group: “Caucasian.” I have already mentioned the issue of the underrepresentation of people of different racial classifications in Stellenbosch town (and wider municipal area), however this desperately needs to be addressed again here. Earlier, I provided a pie chart that

showed that caucasion or white members of the Stellenbosch community are in the minority when compared to the rest of the population of the area. It is extremely telling that 100% of the participants of the focus group were of the socio-economically privileged racial group. This, in combination with 90% of the participants being male further illustrates the point: that SSEG PV is not widely accessible to Stellenbosch residents and, only those from very high income homes can afford to take a more practical interest in these systems. Although the prices of Solar PV technology have decreased globally, they are still expensive in South Africa and therefore inaccessible to the majority of the population (Reinecke et al 2013; Wicht 2016 & Jones 2016).

This section has introduced the reader to the participants of the focus group and provided the relevant socio-demographic information. I have also shown how the data on age, gender, household income and race serve as starting points for areas of future research should any stakeholders agree and decide that this kind of research is necessary to inform future decisions and/ or marketing campaigns. The findings revealed in each of the five themes are now each discussed in detail.

2. Differing perceptions of ‘the problem’

Throughout the discussion it emerged that much of the debate stemmed from the different perceptions of what the electricity-related issues were in South Africa. This is in general as well as from what various sets of stakeholders perceived each other’s issues and aims to be. I summarise the issues raised on this topic as the differing perceptions of ‘the problem.’ It emerged that while there are a broad set of issues that are generally agreed upon (such as the unsustainable nature of coal as an energy source, environmental damage from GHG emissions, increasing electricity process and load shedding), the key differences between the participants and policy makers’ perspectives lie in which issues each stakeholder group chose to prioritise.

This section reveals these finer differences in perception from the participants' perspective (revealed in the focus group discussion) and from the policy and decision makers' perspectives (revealed in the interviews). This section also reveals how each set of perspectives potentially informs the differences in each relevant set of stakeholders' aims and objectives regarding engagement with embedded PV systems.

i. The participants perspectives of 'the problem'

The 'problem' is perceived to be multifaceted, according to both the interviewees and the focus group participants. The participants of the focus group generally prioritised concerns about the state of the environment, the unreliable nature of the electricity provision by Eskom, and fear that load shedding will return in future. They also have concerns about the steadily increasing electricity price. The primary feeling expressed by these participants was one of insecurity about the future of electricity availability in South Africa. Six of the ten responses to the question: "How do you feel about electricity availability now and in future?" were very similar and included:

- "OK for now. Not good for the future,"
- "Not confident, very unsure,"
- "Currently OK but future will have problems," and
- "Currently OK. Future unknown, want to be self sufficient."

These responses indicate a strong feeling of insecurity about the future of electricity supply amongst the participants. There is a lack of confidence in the government and Eskom's ability to meet electricity demand in the future. This is interesting to note because eight of the ten participants indicated that they actually buy their electricity from the municipality and not directly from Eskom. The participants could, therefore, have complained about their municipality instead, and put pressure on the municipality to take a more proactive approach in designing more sustainable

electricity solutions for the future. Instead, Eskom is blamed because it is branded as the only possible electricity supplier in the country. This perception possibly needs to be undone if SSEG or DG is to be more successfully implemented.

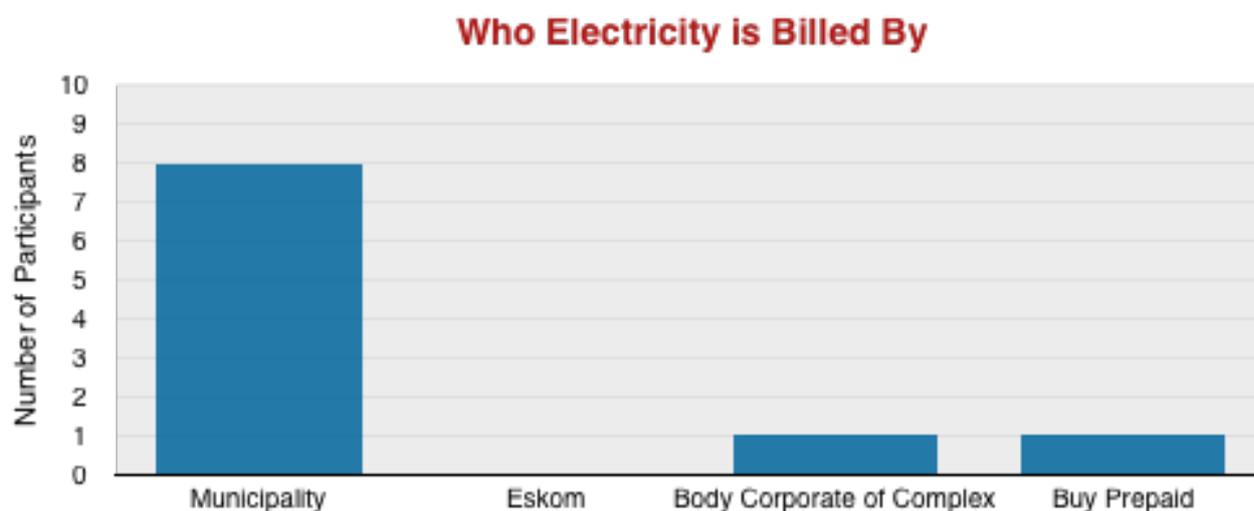


Figure 21: Number of participants who purchase electricity directly from the Stellenbosch Municipality

When combined with information gained from responses to a question about whether or not participants would prefer to go off-grid, the survey results (from Questionnaire One) indicate that these participants would ultimately prefer to manage their lack of confidence by taking control of their own electricity supply. Figure 22 shows the number of participants who expressed interest in going off-grid in Questionnaire One (before the focus group discussion) as compared to responses in Questionnaire Two (after the focus group discussion). More participants expressed interest in going off-grid in the first questionnaire than they did in questionnaire two.

The results from the thematic analysis of the qualitative data indicate that this is possibly due to the high price of storage- which was a topic that recurred in the discussion- rather than due to a preference to install an embedded solar PV system. This is because the response (in the qualitative data) towards the FiT scheme was

largely negative so it is unlikely that participants would choose this option over the option to go off-grid. This is discussed in more detail later.

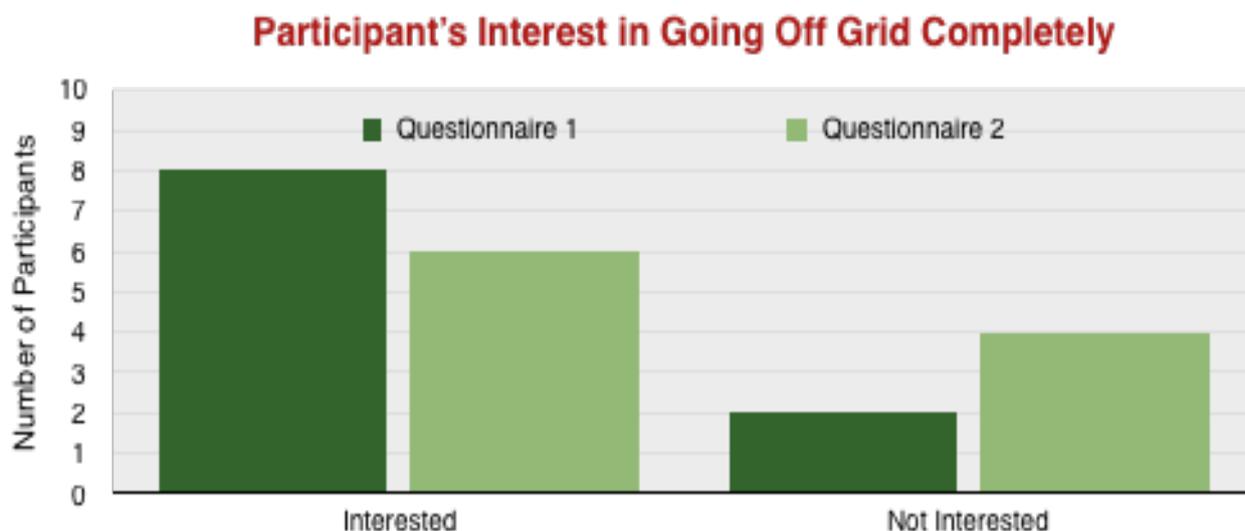


Figure 22: Participants interested in going off-grid

An excerpt from the focus group discussion supports the questionnaire findings and further shows the concerns that these participants share regarding their feelings of anxiety about the future availability of electricity and their own electricity security.

Participant 3: [Interrupts] Um, if you go back to the questions of why you want to put your own system in, I believe that it varies very much from the current situation- last year everyone was scrambling to get hold of an inverter or a generator or these little plug in things... its not an issue at the moment ... why? I've been told its because the mines have scaled down to such an extent and they're the main consumer of electricity because of all the strikes and they've got rid of all of these guys, so I think that's very... let me just ask another question: when do you think when do we think that its going to become a crisis again like it was last year? You know, I've spoken to some guys that I know and they've said the economy is just cruising at the moment and if they get the mines going to get the economy going its going to become a problem- just over night... so the human is a funny thing, when its not a problem you're not worried about it but as soon as the power starts going off everybody starts scrambling for generators, inverters and start putting up panels and everything...

Participant 10: I think the short answer to that is that if this country at any points wants to picking up its economy- we're back in problems ...

Extract 2: Appendix A

[Other participants agree]

...That's the short answer.

Participant 8: But they're building, like crazy green energy plant: the wind and...

Participant 10: Ja but it doesn't solve the whole problem.

Facilitator: Ja I mean we can go into a long discussion on Eskom's woes but the fact of the matter is um, if I talk to people within Eskom, they say that every morning they come to work they are quite surprised the lights are still on.

[Laughter]

Participant 1: Well that's reassuring!

Facilitator: I mean its quite a large number I mean a large part of its fleet- is very old- I mean some of them have been brought back from decommission...

Participant 10: They are actually very good- the engineers are excellent at keeping those plants up and running- they're very good. But its shaky- you know- YOU know also..

Extract 3: Appendix A

Participant 3 also comments on the short-term mind-set of electricity consumers in general and how this is problematic when discussing long-term low carbon energy solutions. This mind-set, and how it could be changed, would need to be addressed by future research projects.

This is important to note because further research, with a more representative sample of the Stellenbosch population, could give researchers and policy makers a better sense of the extent to which these feelings generally exist amongst electricity consumers in the town. However, these responses indicate that a communication campaign to involve, or at least inform, potential consumers in discussions on how to manage their electricity-related concerns might be appreciated and may be useful to opening sustainable opportunities for RE solutions. This is also provided that Stellenbosch Municipality is serious about reducing the number of electricity

consumers who want to go off-grid. This section therefore highlights some of the concerns relevant to these homeowners that are mostly related to the lack of confidence about future energy security and the ability of Eskom to meet future electricity demand. It is also important to note that this is not a complete list of concerns, but rather the dominant ones that emerged. Concerns about the wellbeing of the environment as well as about the steadily increasing price of electricity were also expressed, however I have decided to include these in a more detailed discussion further on.

ii. Participant's aims based on their understanding of 'the problem'

Participant's aims for installing solar PV (and possibly connecting to the grid with a FiT) largely relate to their concerns mentioned above about ensuring electricity supply, saving money and helping the environment. When asked why they would consider installing a solar PV system, the majority of the participants said that they were primarily motivated by the potential financial benefits associated with investing in solar PV systems.

Participant 6: For me, its saving money.

[Murmurs of agreement around the table]

Facilitator: Saving money...

Participant 4: I think for me, its number two. [indicates slide] Ja, it's the having the control. The load shedding is not so much the issue; you can plan your major usage outside those times, as long as they keep communicating. You can plan your usage and just provide lighting in the night and you can do that with small batteries- the new ones.

Extract 4: Appendix A

Two participants discussed their experiences of load shedding and highlighted aims to increase their control over their electricity supply to decrease the inconvenience experienced by load shedding. One participant, however, prioritised convenience over cost:

Participant 10: Everybody has a different um, view, motivator rather. The few times I arrived at home from work, at night, with my family in a *tizz*, looking at me, I realised: I am prepared to pay a hell of a lot of money to have the lights on when I get home!

Extract 5: Appendix A

A different participant raised the key aim: of supporting the uptake of an ‘ecologically friendly’ energy solution. While this consumer stated the importance of this aim for himself, the way he raised the matter indicated that he was unsure of how exactly the installation of an embedded solar PV system can ensure the realisation of ecological benefits. By saying (in the extract below) he would like to help “...Eskom not to burn all the coal, ” *Participant 2* indicates an understanding of the potential benefits of installing solar PV systems but not specifically the potential benefits related to installing embedded solar PV systems. More thought and planning is required to design ways of ensuring, monitoring and explaining HOW the behaviour of installing embedded solar PV systems could translate to actual environmental benefits, because this is not currently clear to the participants.

Participant 2: I would say the um, apart from the possibility of paying less, I hope it is a more ecologically friendly way of life that can be sustained by this and maybe that's an argument that we need to discuss. I mean if I could help Eskom not to burn all the coal and put all the smoke up there...

Participant 1: Or put Nuclear Plants online...

Participant 2: I have an, an ethical view on it... it would be good to hear from you if you think that's uh, sustainable?

TIME STAMP: 00:43:42

Facilitator: Ja well I mean you're asking the converted here, I mean its uh, in my mind at least that's uh, this is me thinking that I am doing something good. I mean I have batteries- at this point my house is probably running on the batteries so- because you can set the inverter to keep the battery store until it is absolutely necessary for load shedding or does it use the batteries you know, in the evening. So at least I feel... 6 p.m. at night... this is peak period for Eskom alright and they're running the open cycle gas turbines at peak capacity on diesel full blast at this point just to keep the lights on. That's bad from the green perspective and bad from the cost perspective so the Eskom figures internally say R 3.60 at this point in time of the day, um, we've estimated more than R4 per kWh from an actual economics perspective... so the C.S.I.R. report already indicated that the renewable energy build programme saved the country R70 million already just in terms of diesel saved and other economic issues. Right but er, now like I said earlier on, one would start with energy efficiency measures, load shifting, before one looks at...

Extract 6: Appendix A

Participant 2 also raised a question about whether or not his ethical view is “sustainable” which indicates further lack of confidence about whether or not it is possible to seriously address environmental issues with the suggested embedded solar PV ‘solution.’ His question was also not really answered by the facilitator- maybe he did not have an answer either? Or maybe a definite answer does not currently exist? Either way, this is something that requires further research. Instead the facilitator confirmed the importance of the ecological reasons for wanting to install solar PV systems and talks about the importance of batteries in decreasing

one's demand for Eskom electricity. This explanation, however, does not gel with the decision to enable a FiT because the FiT is being promoted on the basis that if homeowners could sell their excess electricity back to the grid, they do not have to "...incur the expense of a battery..." (Jones 2016). This shows that while ecological reasons are important to, and common amongst, these participants, there is little guidance for how to ensure their contribution to promoting green growth under the FiT scheme and batteries are also still extremely expensive in South Africa, and globally. The discussion on the affordability of energy storage is raised again further on.

These findings indicate that perhaps a stronger communications campaign and/or plan to harness the potential financial and environmental benefits of solar PV (embedded or otherwise) could therefore be a useful step towards encouraging the development of low carbon solutions. A more informative and engaging approach could also show stakeholders such as *Participant 2* that environmental issues are formally acknowledged and prioritised by the government. A long-term perspective on electricity development and reforms would be required in order for any of these steps to be taken, because environmental benefits are accumulative and can have spin off social and economic benefits as well, that can also be included in long-term plans and in the development of target and monitoring systems.

iii. Participant's perception of Municipality's aims and challenges

The focus group discussion progressed to a point where participants began to express their understanding of the challenges that the Municipality potentially faces. This was done in an effort to understand the logic behind the FiT scheme and appeared to be necessary, because, soon after the FiT scheme was introduced it was declared by *Participant 10* to be unviable from a business perspective:

Participant 10: 60c a kWh is not commercially viable.

Facilitator: [Sighs] Well if I look at my own system at home I can't sell anything so anything I don't store in batteries is lost, in essence, and also lost opportunity.

Co-facilitator: Ja, and also 60c is not that much less than 89c which is what you pay for your first 50 kWh anyway so...

Facilitator: And the other thing is, and we'll get to the cost in a moment and pay back and so on, but we can expect that- well we know what Eskom is going to be asking and for the next couple of years and the municipalities are going to piggy back on that so we can see that that'll go up [indicates the feed in tariff which is Eskom tariff less 10%] so then you'll probably get more for your Rand.

Extract 7: Appendix A

Both the facilitator and co-facilitator attempted to defend the scheme by pointing out that on the one hand, excess electricity would otherwise be wasted, so one may as well feed in at whatever rate one gets and that the 63c/ kW - because its better than nothing. They also point out that 63c/ kW is not that much lower than the 89c/ kW that customers whose monthly electricity consumption falls within the in the first block of the municipal tariff structure. This, however, this does not convince participants and the discussion continues, getting rather heated at times.

The participants then began to try and make sense of why the tariff was structured the way it was, in light of the realisation that it did not appear to present a financial incentive to them. From the excerpt below, the understanding emerges that having a solar PV system is more viable if one's electricity consumption is already extremely high, therefore potentially increasing the savings one can make. The extract below also highlights the participants' perspectives on and understandings of the

challenges that the Stellenbosch Municipality could be facing and that they may have taken into consideration when designing the FiT.

Participant 10: The hope is that if you do install a solar PV system you'll move yourself into a lower demand bracket [referring to Municipality's step tariff system]

Participant 8: But they don't want the 83c clients in theory.

Facilitator: No they don't really.

Co-facilitator: They're the municipality! They HAVE TO take the 83c clients, you know, I mean that is what the Municipality IS. It's a service, you know, so they need to make their books balance. That's basically what it is. Just the same way you want to install a solar PV system and you want to make your books balance and you want to not lose money out of it etc. the municipality also provides to everybody and those people who are only on 50 kWh... well the first 50 kWh would be for free, but then they pay 83c, you know those people won't be the people who can afford to put PV systems on. They are the poorest of the poor.

Participant 10: Ja, I use about 50 kWh a day.

Co-facilitator: 50?! Ok, you see there you go... you're not paying 83c, you're paying R1.78

Participant 8: Ja... he's got PV.

[Laughter]

Extract 8: Appendix A

This quote raises the issue that participants are aware of the Stellenbosch Municipality's double challenge of generating revenue from the sale of electricity and of supply of subsidised electricity to lower income households. *Participant 8* also highlights his understanding of the potential challenge, for the Municipality, of having an increased number of electricity consumers who are reducing their

electricity consumption, effectively reducing the revenue collected by the Stellenbosch Municipality.

The financial model was initially designed to manage the challenge highlighted by the co-facilitator in the extract above: that the Stellenbosch Municipality still needs to provide affordable electricity access to lower income groups. In the face of increasing electricity prices and the worsening effects of climate change (due to climate change and GHG emissions) however, the municipality may benefit from generating further research into how to manage their challenges with more low carbon energy solutions.

The participants, the facilitator and co-facilitator also speculated on the reasons that have motivated the Stellenbosch Municipality's decision to agree to enable a FiT scheme as well as on why the scheme was designed the way that it was. This is evident in the extract below, where the facilitator expresses a lack of clarity on why the FiT rate is specifically set at the Eskom rate less 10%, and not 12%, for example. This is an important point because it indicates that there was a lack of clarity in the design of the FiT scheme.

In the following excerpt, the facilitator also provides some insight into their understandings of the other challenges that embedded PV generation presents to the municipality. This extract indicates that the facilitator and co-facilitator (who represent researchers of the CRSES and who worked with the municipality to promote the release of the policy and FiT) have a better understanding of the Stellenbosch Municipality's challenges and they attempt to convert the extent to which the actions of the municipality are dictated by inflexible national policy, to the participants.

Facilitator: Um, just to highlight some of the municipality's challenges is that they pay Eskom a time of use tariff, ok, and depending on seasons, days, etc. they can pay Eskom more than R2 per kWh, so it means that they selling electricity at a loss, but they pay Eskom a very low tariff during the day and then they selling the electricity to you at that rate (indicates slide) so that's how their financial model works. Now you can also understand their position because I mean your PV systems are going to be generating electricity exactly at that time of day when the municipality would actually want to sell that electricity. These are some of the issues. Um, alright so this is now for around uh, self generation and the actual buy tariffs are very similar but I want to highlight here uh, so this is the fixed linking cost per month: R140 and then they will reimburse you for the energy at the Eskom tariff minus 10% so I think if I'm right it would work out to about 60c at the current tariff so it's probably going to go up to 70c- they going to buy electricity from you at about 63c an hour...

Participant 10: Not time related or...?

Facilitator: No

Participant 10: Just flat?

Facilitator: Yes. Its flat, alright and um, the reason for that, I don't actually understand why -10% to be quite honest but NERSA said the municipality can't pay more than they would pay Eskom...

Co-facilitator: Its in the Electricity Pricing Policy, its actually law that no municipality is allowed to purchase electricity at a higher rate than what it can be purchased for from or otherwise...it's an old law that came out from, you know, sort of municipalities purchasing it at whatever um, rate.

Extract 9: Appendix A

This section has provided insight into how the participants (10 residents) and researchers (the facilitator and co-facilitator) who participated in, and facilitated this focus group understand the challenges faced by the Stellenbosch Municipality. These perspectives are fairly accurate, however I have shown that in some cases they are heavily influenced by a neoliberal approach to electricity and market development rather than by a social development perspective. From this discussion,

I have also conveyed the emergence of a perceived lack of commitment from the Stellenbosch Municipality towards managing issues such as ensuring future, affordable electricity security with RE and of developing long-term plans to ensure and measure progress towards achieving related environmental benefits. These perceptions have resulted in deep feelings of frustration of participants towards the policy makers. Below is further evidence of the frustration participants feel towards the lack of long-term vision and consideration of potential long-term environmental and financial benefits of PV technology by the Stellenbosch Municipality.

Participant 1: You know the country has a big potential here, and if they pushed it- if the government pushed it, that um, people maybe even had better subsidies if they invested in this type of stuff, but to encourage people to invest in this, and to sell back and I think they should have the meters turning in reverse, and uh, and reap the benefit of reducing the national load on the, on Eskom, and get Eskom out of the crap that its in, at the moment and not have to put up nuclear, new plants and stuff like that, it would save them in the long run. But government is government, and they don't want to do that! They would rather see Eskom struggle than to actually do something that is more beneficial and is more business savvy so it's always going to be an issue! You're never going to- why spend- as you say- thousands, tens of thousands- hundreds of thousands- to get nothing back? You might as well just service yourself and get the heck off the grid! And not work with government. You're green, that is a benefit, um, and you don't have to deal with the admin, the tariff hikes, all the rest of the crap from government whether its Eskom or municipal...

Participant 10: The Dilemma here is that um, the more people who get off the grid, or reduce their demand, the deeper trouble Eskom is going to have-

Participant 1: The more trouble Eskom is going to have...

Participant 10: They're losing their best payers- that's the problem- they just remaining with all the bad payers now I don't know how they are going to solve that problem...

Participant 10: They're not doing it from a business perspective and that's the problem with government...

The frustration I refer to above is evident in Participant 1's input that essentially criticises the “government” (and Stellenbosch Municipality) for not prioritising the management of broader issues such as getting “...Eskom out of the *crap* that it's in” and to ensure that they “reap the benefit of reducing the load on Eskom.” This participant strongly believe that and taking a more “business savvy” approach would have better enabled the government to manage the broader issues relating to electricity security at utility scale. This also demonstrates, however, that the participant has a lack of understanding of the potential implications that enabling a purely “business savvy” strategy could have on poorer electricity consumers. It is also interesting to note that blame is now shifted from *Eskom* (as noted earlier) to *the government* (national or municipal? It is unclear.) This criticism therefore stems from strong feelings of mistrust in the “government” objective, however, it also shows that this participant also does not understand the role of municipalities as service providers to the rich and to the poor and that taking a business perspective is not affordable as long as municipalities operate according to the current financial model. It also highlights the need for a more dynamic and multifaceted alternative to the business approach and to the development approach that are essentially clashing here.

The consequences of this miscommunication of role and misunderstanding of objective is highlighted when the participants continue to discuss the very real danger that those who are *fed up* with ‘the government’ will simply reduce their reliance on Eskom supplied electricity and possibly go off-grid completely. This has the potential to cripple municipality's ability to viably provide their services, particularly electricity, and should serve as a primary motivator to engage in the development of more long-term, low carbon, plans to supply electricity affordably and sustainably. The strategy to desperately cling to existing financial models by fitting in a FiT scheme in has not convinced these participants that the Stellenbosch Municipality is committed to encouraging the uptake of embedded solar PV systems, ensuring secure, long-term, affordable electricity supply or in promoting sustainable, green electricity development, given the nature of the scheme on offer.

Any attempts, on the part of policy makers, to engage with homeowners will have to be sensitive to these feelings of mistrust, frustration and with the misunderstandings revealed.

iv. The policy and decision makers' perspectives of the problem

The policy makers' perceptions of 'the problem' were revealed as being generally two fold. On the one hand, there are general challenges related to achieving their mandate and on the other, there are additional challenges presented by the introduction of a FiT for managing embedded solar PV systems as well as by the promotion of energy efficiency measures.

Mr Coetzee, head of the Electricity at the Stellenbosch Municipality, explains that the general, day-to-day challenges involve (Coetzee 2015)

- The municipality's ability to meet the increasing electricity demands of the growing town and keep up with maintenance and grid expansion on the budget allocated. These challenges also include those related to how to ensure that electricity users from low LSM groups were able to access subsidised electricity;
- The technical challenges posed by the current condition that the grid is in at the moment because there are maintenance backlogs and upgrades of transformers and cables will need to be done soon;
- Pressures from Eskom where electricity shortages and load shedding occur; and
- Pressures from the developers who want the grid extended to their new building projects.

He also mentioned that he felt that his department was under pressure from a number of angles in relation to the uptake of embedded solar PV systems with a FiT:

- Pressure from members from the CRSES to get a FiT for residential scale solar PV, however, Mr Coetzee also explained that, while he was aware of the CRSES' agenda to push for a FiT, he did not believe that the municipality had the finances available to encourage the uptake of embedded solar PV systems at residential scale;
- Pressure from the political players (no names mentioned) in the municipality who are worried about revenue loss and its potential effects on the grid maintenance budgets as well as all other services (water, sanitation and refuse removal) that are subsidised from the revenue generated from the sale of electricity;
- The concern that if those who demand the most electricity and pay the highest bills start to reduce their electricity bills via solar PV or energy efficiency installations, there will again be less income to subsidise the electricity to the poorer communities;
- A very real concern expressed by both Mr Coetzee and Mr Jones (2016: 6) is that wealthy homeowners would actually prefer to go off grid completely. This is a legitimate concern, given the frustration and intentions expressed by the homeowners themselves as shown in the previous section;
- Residential scale embedded solar PV systems are likely to feed excess electricity to the municipal grid in the middle of the day, which is typically a time of lower electricity demand and a time at which the price of electricity is already lower. The consequences are therefore first, that

the amount that the municipality could technically pay in exchange for electricity fed in by embedded solar PV systems is decreased and, second, that excessive feed in at times of lower electricity demand presents challenges to grid stability.

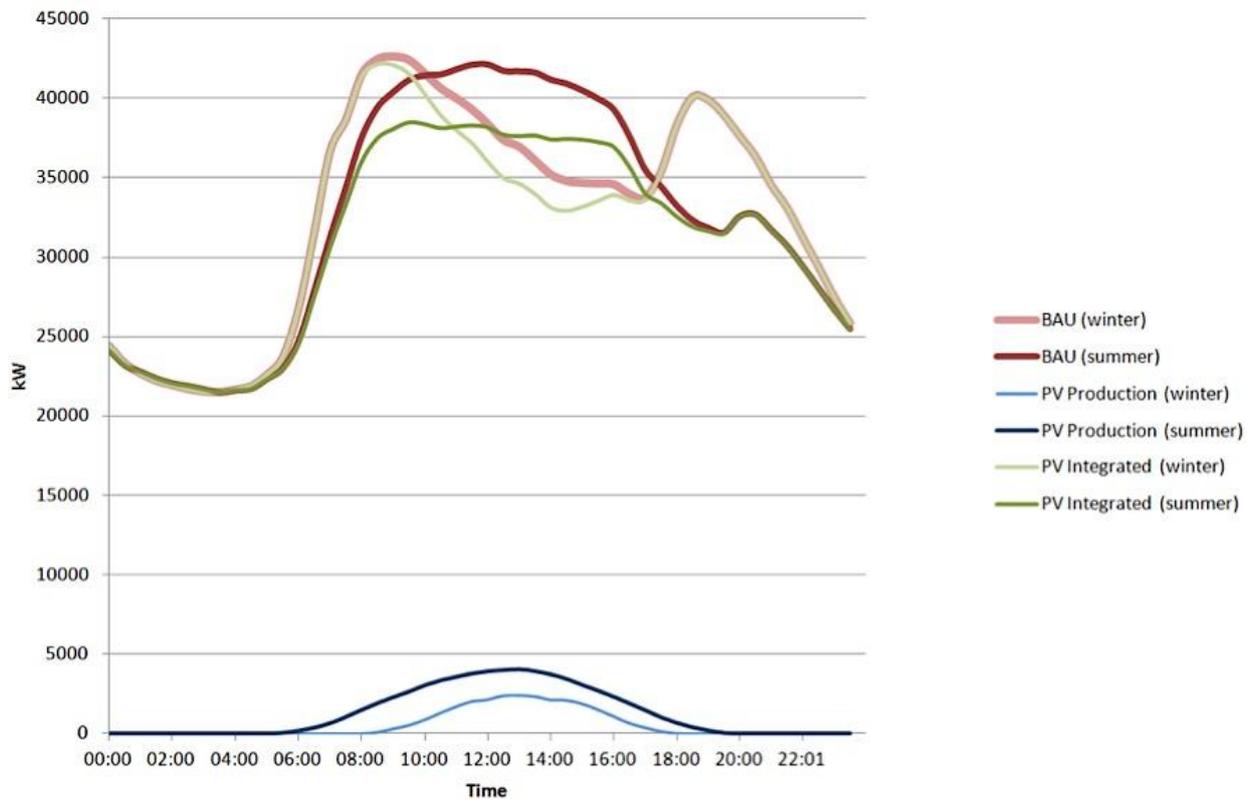


Figure 23: The typical electricity demand profile for Stellenbosch (Source: Energy Working Group, 2016)

The graph above shows the morning and evening peaks (yellow line) as compared to the midday peak in electricity generation from solar PV systems (Blue and green lines). The peak SSEG PV generation in summer (dark green line) matches the electricity summer demand profile (red line). (As an aside, the graph above also highlights that in Stellenbosch, in the summer, the electricity demand profile looks different to the conventional double peak profile (red line). This line indicates that the summer demand profile does not have such extreme morning and evening peaks

but rather a midday peak (Energy Working Group 2016). This represents an opportunity for how the municipality could plan for the promotion of the useful uptake of SSEG PV amongst residential and commercial electricity consumers because it has the potential to reduce the amount of electricity that the municipality has to purchase from Eskom in the first place. Essentially, this highlights that research into electricity demand profiles of more specific areas could be very useful to future SSEG PV planning).

Interestingly, Mr Coetzee (2015) also explained that when he first started in his position as the Head of Electricity, no one had even heard of RE and so they never planned for it. He mentioned that it is only now; that the discussion has gained momentum rapidly, that his department and the Stellenbosch Municipality are being “forced” to consider the implementation of a FiT.

This shows two things; i) the drive for the uptake of embedded solar PV in Stellenbosch generation does not actually come from the municipality and, in fact, is perceived to cause a great deal of inconvenience to them; and ii) the lack of forward thinking and long-term planning for sustainable, green electricity development that has been accepted as the norm in the municipality and that the participants have highlighted in the previous discussion. In addition, the perception that embedded solar PV is being “forced” on the municipality by external factors is problematic because it is hardly conducive to the development of a sustainable energy solution as all stakeholders clearly do not buy-into and accept the idea.

Mr Jones, head of Green Energy for the City of Cape Town, corroborates the understanding of issues for the municipality as raised by Mr Coetzee. Mr Jones also further emphasises that the call for the uptake of embedded PV does not come from municipalities but in his opinion, from the PV suppliers who are “...trying to make a living” (Jones 2016). He also raises several other issues, such as the lack of policy guidance from national government for the uptake of SSEG and that municipalities have resorted to developing reactionary policies (rather than proactive ones) to

regulate the process. The primary issue that Mr Jones (2016) raises is that the money to finance the FiT scheme for embedded PV needs to come from somewhere, but he is not sure where it will come from. He is therefore sceptical about the extent to which homeowners actually stand to benefit from investing in SSEG systems and of municipalities' abilities to finance them without putting themselves into financial difficulty.

Mr Jones: Ja! It is.. um a lot of people... you know there is no legislation... the electricity supply industry is highly regulated and you cant breathe without having some law telling you what you can and can't do and um, it goes back to the electricity regulation act and there is nothing in law which gives any direction as to how you handle small scale embedded generation and the National Energy Regulator has been working on a set of rules, um, and they should've been issued about a year ago or so... but they haven't been so we just felt that we had to put something in place from an electricity distributor point of view so that... to... sort of stem the flow of people connecting illegally to the grid- to Eskom's grid and to... throughout the country um so it is reactionary from a electricity perspective... um but the city also has a strong sustainability drive and um, and it has.. the city... from many different angles would like to see um... PV proliferate from the job creation point of view... and the economic benefits of that uh... from the climate mitigation point of view... um... uh, ja and from you know... kind of the green image of the city as a destination for investors is just multidimensional so you know there are challenges to electricity revenues as with energy efficiency and it kind of upsets the apple cart just in terms of the way scientific knowledge has been applied in the past to the distribution of electricity because all of a sudden you've got something that is completely unpredictable and um and really disrupts operations in many ways so... ja... it's been a big learning curve. It hasn't been resisted in any way but it has been, I would say a bit reactionary from ... or... ja. [pause]. And I would say "reactionary" because there hasn't been legislation in place to guide- you know?

TIME STAMP: 00:06:03

Researcher: Yes, it definitely seems like there is an idea of where we want to go, and then there's... who is it do you think who is driving the uptake of rooftop PV? Do you think its residents or organisations like Green Cape or...

Mr Jones: I think it's suppliers of PV equipment- people who are trying to make a living...

It is interesting to note that similar challenges exist for the CCT. Both the CCT and Stellenbosch municipality have the perception that facilitating the uptake of, and managing, embedded solar PV systems are, in fact, highly inconvenient for both municipalities. Another similarity appears to be that neither policy maker is able to clearly explain concrete plans for guiding and monitoring progress towards ensuring that potential benefits (such as “climate mitigation and job creation” in this case) are realised.

Differences exist in the understanding of the issues from the Stellenbosch Municipality’s perspective as compared to the participants’ (as homeowners in Stellenbosch) perspectives. While homeowners believe that the municipality is attempting to provide an incentive to encourage them to install embedded PV systems for environmental benefit, the Stellenbosch Municipality, who enabled the FiT, did so grudgingly and despite the significant challenges the scheme presents.

Mr Jones (2016) also confirms that the policy was released purely in response to the current practice that some homeowners have. Participants revealed that homeowners who still have the old disk meters could (and in some cases have) illegally connected their solar PV systems to the grid and simply allowing the meter to spin in reverse in order to feed excess power onto the grid. Homeowners who do this are able to “sell” their excess power at the same rate at which that they buy electricity and therefore can enjoy substantial reductions in their electricity bills at the end of every month.

Participant 10: But the net-metering is illegal as far as I know, at the moment.

Facilitator: Ja, its illegal

Participant 10: Ja but guys are doing it, if you lucky enough to have one of those old disk...

Mr Jones (2016) also speculates that some homeowners are interested in solar PV for different reasons. He believes these include: (i) some people are motivated by the “greenie” agenda (homeowners who want to install these systems for environmental reasons) and (ii) that some homeowners believe that they can save money by installing them. The interview discussion also revealed that he is sceptical about the ability for homeowners to realistically achieve either of these goals under the current scheme and if they do manage to save some money, he is not convinced that it will be a huge amount. This is important because it shows that Mr Jones has a more accurate view of participants’ views and goals and that if he, as a policy maker is unoptimistic about the realisation of the potential environmental and financial benefits of embedded PV, where does that leave the participants?

The concerns prioritised by a policy maker, Ms Cabral Wicht, a representative of the Energy Game Changer project, provide insight into the perceptions and aims relating to solar PV at provincial level. These perceptions and aims are quite different to those raised by the municipal policy makers, Mr Jones and Mr Coetzee. However, they are more similar to what the participants would prefer them to be.

The Challenges, according to Ms Wicht (2016), relate to how the province would facilitate the development of a local green economy in order to attract international investment. This type of proactive, *business savvy* approach is more in line with what the participants expected from their municipality as expressed in the previous discussion. Facilitating and nurturing sustainable markets for RE technology is key to achieving their mandate, according to Ms Wicht (2016). The main problem addressed by the Energy Game Changer is therefore the challenge of promoting low carbon growth in the electricity sector of the future green economy and of opening sustainable markets for energy efficiency and RE technologies.

Mr Coetzee therefore raised the issue that municipalities face two categories of challenges: first general challenges related to fulfilling their mandate and second, those that relate to enabling embedded PV generation with the FiT scheme. As

shown above, Mr Jones (2016) corroborates the existence of these challenges and their relevance to the CCT municipality as well as to the Stellenbosch Municipality. The participants demonstrated some understanding of these policy makers' challenges and vice versa, however, improved communication could be extremely useful to both participants and policy makers to manage expectations.

Ms Wicht (2016) highlights her perspective (that provides insight into the provincial perspective) of the problem and associated perceptions of their need to encourage the development of a green economy for the province. While this perception gels more with participants perceptions of the problem and potential solutions, these may not have not been successfully communicated to municipalities.

While Ms Wicht demonstrated an understanding of the perceptions and challenges faced by municipalities in general, she also mentioned that she felt that the province had limited ability to assist municipalities with their challenges and that more support is required from national government.

All these policy makers mentioned their environmental concerns, however these were not always mentioned as being considered priority concerns. Rather, they were mentioned in passing, as some of the potential benefits of installing embedded PV (without saying exactly how this benefit would be harnessed or monitored). This shows that there is possibly some truth to the participants' perceptions that this aim (of promoting environmental and ecological health by reducing a reliance on fossil fuels for electricity generation) is not prioritised by some of their government representatives.

v. Municipal and provincial policy and decision makers' aims, given their perspectives of 'the problem' and their state challenges

From the discussion above, it is clear that the primary reasons for why the Stellenbosch Municipality is taking steps to regulate embedded solar PV are to

ensure safety and to protect their revenue streams. This municipality drafted these regulations without first taking the perspectives from potential consumers into consideration, nor did the municipality inform them accurately of their intentions and objectives. Instead, the FiT scheme is sold on the assumption that the technology itself has “environmental benefits” and can assist with achieving “energy security in the country” (Wicht 2016) Homeowners have the option to connect, if they want it. No long-term objectives or plans exist at municipal level that would detail exactly how these objectives (of ensuring environmental benefit and long-term energy security from RE resources) will be met and monitored.

Homeowners (the participants) can be forgiven for jumping to the conclusion that their local government was providing an ‘incentive’ because there is also the widespread belief that local government wants to incentivise the uptake of embedded solar PV systems. It is also believed that their contribution of embedded electricity (feed-in) could make a contribution towards the development of the Green Economy in the Western Cape because, as explained by Wicht (2016) the Western Cape Provincial government aims to market itself as an innovative investment destination for international renewable energy (and other) companies. This perception is highlighted in the extract below where Wicht (2016) highlights all the reasons for why there is such emphasis on the promotion of the uptake of PV.

- Ms Wicht:** Ja, so... people often have this perception of government that its... you know... boring, so what we've tried to do is to do things differently, because its also a different sort of space, you need to be able to do things differently and work out of the usual government mould...
- Researcher:** Just to steer back to the PV conversation.... Why PV? Why have so many different stakeholders (Green Cape, the CRSES, some homeowners, the City of Cape Town and so on) selected embedded rooftop solar PV as "the solution"?
- Ms Wicht:** So rooftop PV was identified because if all the necessary regulations and systems are in place, it would be a very quick "win" in terms of ensuring energy security for the Province and... um... so... um... with the price, you know, having come down so dramatically over the last few years and the technology evolving at such a fast pace, we just felt that this would be... um... sort of a good area where we could get people excited and involved in so like when the Tesla battery was announced, it was like this huge global thing and everyone got super excited so because of the new technology that people are very interested in and we can sort of latch that interest and gain, and encouraging people to become part of... of making a difference in terms f their own energy behaviour and... ja...
- Researcher:** Ja, I suppose its something that they can do themselves...
- Ms Wicht:** Yes exactly, it is. Its within their own sort of sphere of influence and they can take control of their energy... because also in South Africa with, you know, issues with Eskom and stuff, people... and load shedding... People felt very powerless and so that is something where they can say "well I can do this and with the encouragement of feeding back into the national grid, I am helping the nation around... um, the energy security."

Extract 13: Appendix B

Ms Wicht (2016) raises some important points around the excitement attached to the idea of owning a solar PV system, and, given that the prices of the technology have come down so much, an increased uptake of this technology can result in a "quick win in terms of ensuring the energy security for the province." She does not, however, explain what plans, mechanisms or processes are being implemented to ensure such a key benefit is realised or how progress towards attaining such a vague goal would be measured. When questioned further, it emerges that solar PV systems are technically only capable of doing this if they are installed with battery packs to reduce load peaks and encourage people to use less Eskom electricity- a solution

that does not necessarily involve the need to feed in with a FiT scheme. More in depth discussions with policy maker representatives on this topic are required to delve more deeply into this question and could be an interesting avenue for future research.

In the absence of ‘a more holistic plan’ and set of guiding policies from national and provincial governments, Mr Jones (2016) explains that municipalities, such as the City of Cape Town prefer to move forward with caution when it comes to taking steps towards the decentralisation of energy generation at local government level. This is wise on the one hand, because it potentially prevents unintended consequences and is ‘safer’ in that sense; however, it is also not conducive to a deeper engagement with the interconnected issues and the development of more radical, solutions for sustainable development.

Mr Jones: So Cape Town’s approach is conservative... I get concerned that we generally are power engineers, we’re not modern cell phone app, data... and I think... I just get a feeling that we have to be very careful that we don’t get overtaken like cell phone companies have taken away the business of Telkom. We have to be careful that we don’t get caught like that but also not just run ahead and shoot ourselves in the foot by rolling out systems, which are premature.

Extract 14: Appendix C

There are therefore a number of different sets of perceptions of ‘the problem’ and aims for its resolution regarding the issue of the uptake of embedded PV generation at residential scale. These perceptions inform a range of different aims of the different groups of stakeholders involved that have not been adequately communicated to one another. The consequences are that feelings of contempt, mistrust and frustration are rife amongst the potential consumers who participated in the focus group, towards their perceptions of government. Interestingly, feelings of scepticism also emerged from Brian Jones (2016) towards homeowners and their

determination to install PV to be “green” or to make money because there is no way to guarantee or measure the extent to which they will actually realise these benefits. These feelings are not conducive towards future cooperation and could also represent barriers to the uptake of DG and SSEG PV in future. Further research would be required into whether increased communication between policy makers and residents could help the situation. .

This section has shown the incoherent nature of the discussion on the uptake of embedded solar PV in the Western Cape, particularly at provincial and municipal level, with reference to Stellenbosch Municipality. It served to introduce the consumers’, researchers’ and policy makers’ perspectives regarding the idea and highlights, above all, a serious lack of transparency and communication between stakeholders. As a result, the suggested FiT scheme does not enjoy support from many- except maybe from the facilitator and co-facilitator and Green Cape representatives (who were very involved in motivating for the FiT scheme to be released by the Municipality). The reasons for this support can be gathered from Reinecke et al (2013) but they primarily relate to attempts to open the market for solar PV technology systems in an effort to further reduce the price of the technology. While well intentioned, the success of the scheme in opening and promoting a sustainable market for solar PV in Stellenbosch is threatened by this lack of communication with consumers and the idea that the municipal representatives interviewed do not necessarily buy into the idea of actively promoting the uptake of SSEG PV themselves. This discussion now turns to the consequences of the lack of communication and misunderstanding of the different aims and challenges between the stakeholders involved.

3. A clash of contradictory objectives

The most serious consequence of the lack of communication is that the negative feelings that the participants expressed have served to create a situation where two

potentially hostile sides emerge. A more antagonistic nature between the homeowner and the Stellenbosch Municipality emerges.

i. Municipality vs. homeowner

I have already included a discussion above to illustrate that the electricity-related issues in South Africa are multifaceted and it has, so far, emerged in the focus group and interview findings, that different stakeholders tend to prioritise different aspects of the problem and, therefore, have different understandings of how the problem is to be 'solved.' Complexity theory, however, shows us that the quest for such solutions do not exist for complex, multifaceted problems involving multiple stakeholders and that attempts to 'force' solutions without stakeholder engagement only serves to exacerbate the problem (Chu, Strand & Fjelland 2003). This section looks at the details of how the situation has been exacerbated by the lack of engagement and communication between stakeholders: the participants and the Stellenbosch Municipality.

The aspects that each stakeholder prioritises are also the aspects most relevant to them and there is some, albeit limited, effort made by each side to understand the others' perspectives, challenges and needs. In this context, the primary consequence was that homeowners rejected the FiT scheme, because it did not serve as a means for them to meet their objectives. Because the Stellenbosch Municipality designed the scheme, with the help of GreenCape, the scheme is more able to meet their objectives to simply, as the facilitator explained, "...regulate the new trend where electricity consumers become generators as well..." (Focus group discussion 2016).

A statement from Mr Jones further indicates that the municipalities have prioritised their own objectives and have instead offered homeowners an indirect (rather than the expected direct) benefit from installing embedded PV systems. This explanation shows that there has been some consideration of (assumed?) consumer needs because the way that the tariff is designed offers the homeowner some "indirect"

and unintended benefits. This benefit, he explains, is that consumers can install larger systems without worrying about wasting excess electricity. This does not necessarily speak to consumer needs, as it is different to the needs expressed by participants in the focus group, as shown in the previous discussion.

- Researcher:** So then how is this whole 'Feed in Tariff' expecting to increase the uptake of PV?
- Mr Jones:** Well... its not. It's not designed to... except um, the issue is that people... let me find a pen [draws out consumption peak]... your residential peak, you know, *[goes on to explain the tariff is to incentivise load shifting and to enable customers to size their systems a bit bigger to have the capacity to meet winter demand and have a way of getting rid of excess electricity generated in summer- to sell it to the grid so it is not wasted.]*
- Researcher:** ...because they're using more of what they produce instead of paying the tariff for electricity during the middle of the day AND by shifting their load from morning and evening peak periods they are not paying the higher tariffs for those times.
- Mr Jones:** Ja. So I mean that's one of the kind of- unintended- benefits of the way the tariff is structured encourages people to switch their swimming pool pumps on in the middle of the day instead of at night and also to

Extract 15: Appendix C

Further on in the interview, Mr Jones also mentioned that encouraging a rapid increase in the uptake of embedded solar PV systems is not ideal...

Mr Jones: Well when you say “what are we doing about that” you know there is also a very practical aspect of this is the capacity of the municipality to handle applications and problems which arise out of increasing PV, um and if I’m honest, I think that I don’t want to see this promoted beyond the capacity of the municipality – there is a learning curve all round here. So I think there is a kind of natural progression which is great...

Extract 16: Appendix C

Much of the evidence for the participants’ objectives has been used above to illustrate the expression of their perceptions of the problem and their needs. However the extract below highlights their prioritisation of their need for a secure, affordable supply of green electricity and, that this need is placed above any understanding of municipal need. The implication is clear, if the municipality does not engage with consumers or meet their needs, the consumers, who can afford to, are simply going to turn their back on the municipality. There is little evidence to suggest, however, that the participants have considered all the implications for them that going off-grid could have and this could warrant further investigation.

Participant 1: You’re never going to- why spend- as you say- thousands, tens of thousands- hundreds of thousands- to get nothing back? You might as well just service yourself and get the heck off the grid! And not work with government. You’re green, that is a benefit, um, and you don’t have to deal with the admin, the tariff hikes, all the rest of the crap from government whether its Eskom or municipal...

Extract 17: Appendix A

These needs are also prioritised over all others and the suggested solution requires a “business perspective” (*Participant 1*) that enables an open electricity system to

incentivise the uptake of embedded solar PV systems. *Participant 10* furthers the argument and suggests that the Stellenbosch Municipality, as shown in the extract below, considers a wheeling arrangement. This suggestion also shows a lack of consideration of municipal mandates and the challenges and barriers presented by the municipal financial models and governing policies.

Participant 10: I just cant help thinking, you know that there is a mechanism and there are a lot of hurdles to get over that but its more viable if a private person sells to a private person, you can then charge any rate you want- you just need to cover the cost of wheeling in between so the if the municipality is prepared to mask this under people selling to each other, and I'm selling to the school and I'm selling to the... then you can set up the rates that makes sense for both parties. The school is still saving because he's not paying as much as he would have from Eskom or the Municipality and the other guy is not getting 60c, he's 80c or 90c... or whatever.

Facilitator: Ja that's interesting discussion as well is that we don't have a standardised wheeling tariff because that effectively could- the municipality could still make money, out of the wheeling tariff...

TIME STAMP: 00:52:43

Participant 10: Yup, exactly you just cover their wheeling cost and then so... this thing where you're subject to the national policy- what is it- the mega flex rate or something? I can't remember, its not going to work. Not commercially, not so far as I can see.

Extract 18: Appendix A

The trouble, therefore, with moving on to designing and releasing potential ways of managing a problem- before a coherent and fully representative understanding of the problem has been agreed upon- is that there are a number of reactions to the 'proposed solution' (in this case, the FiT scheme) that can result in negative consequences.

Complexity theory may provide some guidance on this matter because, central to the theory is the process of developing a coherent, agreed upon, understanding of the problem at hand and the recognition of its complexity due to the involvement and interaction of different stakeholders (Cilliers 2000b). This understanding, according to proponents of complexity theory, needs to be developed with the participation of all the relevant stakeholders in a transparent process of engagement so that everyone is clear of the various issues and the aims and objectives can be geared towards more integrated ways of managing the problem (Cilliers 2000a; Cilliers 2000b; Cilliers 2006; Cilliers 2008 & Chu et al 2003). This will be discussed further in chapter 5.

4. Consumer related feedback

Much of the focus group discussion centred on the Participants' views on the viability of the FiT scheme for them, and, the theme that dominates this section is that this FiT scheme does not meet consumer expectation.

These participants came into the meeting with expectations that they could make good money off an embedded solar PV system with a FiT scheme. This was revealed in the second question that was raised while the facilitator was introducing the topic for discussion. The excerpt below indicates the high expectations among participants as expressed by *Participant 3*:

Participant 3: Are we going to discuss mainly how this affects us in Stellenbosch? And what their policies are going to be in Stellenbosch because I've heard of various means of them and various levels of how its been applied already so for example in Cape Town you can make so much and can feed back and then you can reverse the tariff and then some of these guys are ending up with like a R7 bill for a million rand mansion...

Extract 19: Appendix A

This quote also shows the existence of rumours and myths relating to embedded solar PV systems and their capabilities. These expectations are unrealistic, given the challenges faced by the Stellenbosch Municipality highlighted above and in the South African context. Much of this expectation can be attributed to the need (that exists amongst the participants of this research study) to continually compare South Africa's embedded solar PV context to that of Germany. This is problematic because, as shown in chapter 3, developed country contexts have vastly different challenges and opportunities to developing country contexts, such as that South Africa. Modelling the development of the embedded solar PV market on that of Germany is unrealistic to a large extent because the policy context, let alone the socio-economic disparities – are vastly different to South Africa as Germany's government buys into clean RE development, whereas South Africa's true commitment to the idea is questionable. Evidence for this natural comparison is provided in the extracts below.

Ms Wicht: So, I'm not actually sure what they're looking at but I'm not sure what would be an option- you know in Germany you have the option where you can rent your neighbour's roof, you know, that sort of stuff... I'm not sure we're at that stage just yet, um I think also because...

Extract 20: Appendix B

Facilitator: and then.. and this is an exciting point for us and is seen as a tipping point for renewable energy... (you all know about the renewable energy big bill programme thats happening around the country... so at utility scale its sorted out but we're still struggling in this country for small scale compared to other countries like Germany, some places in the states and so on... where indeed you can be connected to the grid and you feed back surplus electricity into the grid and the municipality or the utility pays you.)

Um... just, just so you know its not something that is entirely new in South Africa... there are some people who have been generating and selling back to the grid but at this point in time there is no standard policy framework that governs all of that. Its usually a one on one situation between an entity and the Municipality or Eskom. Usually its between another entity and Eskom- as far as I know. Right so its that third one that we're really interested in from our side.

Extract 21: Appendix A

This shows that there are expectations (among participants of this case study) relating to the potential financial opportunities presented by the FiT and that this expectation is fuelled, at least in part, by rumours and hearsay and by the tendency to draw parallels between what has been achieved in Germany and what could, hypothetically, be achieved in South Africa. These expectations will need to be researched in more detail in order to find ways of managing them as they can potentially fuel emotional responses from stakeholders towards RE initiatives, as shown above.

i. Embedded PV is NOT viable at these rates!

One of the key consequences of unmanaged expectations, the lack of community engagement during the early stages of planning the FiT scheme, and differing perceptions of the problem, is that the FiT scheme for Stellenbosch was strongly rejected by the focus group participants, on the grounds that it is not in fact the financial incentive that they had hoped for. Other issues around the viability were raised in relation to (i) feelings of lack of confidence about the long-term

investment opportunity; (ii) anger towards the additional R140 grid connection fee; (iii) potential effects of the FiT on the pay back period, (iv) the effects of human nature on the potential benefits offered by the technology and (v) the issue of proactively determining one's needs and then determining whether or not the FiT helps by making the meeting of those needs more viable. The first extract below shows the feelings of dissatisfaction with the FiT even-though Eskom prices are likely to increase dramatically in future.

Participant 3: When do they expect this new um, nuclear one to come online?

Earliest is 2025 I think. I'm told by one of these retired professors that at a maximum those plants are only going to last for a year, so we will, they said even if the mines don't get going and overload the system, the old ones will conk in before the time and then you will have to put something in place -if you don't want to end up in the dark...

Participant 10: If I can just compound that: the current price path on Eskom rates, which is quite a steep curve, does not account yet for that new build. So as soon as they want to replace any of those stations, the price has to increase more than 12% per year so...it all speaks to the justification for doing your own thing. But feeding back, I think that's one of the things you wanted to hear today, my opinion is at those rates: not worth it! [Shakes head]

[Murmurs of agreement from all round]

Extract 22: Appendix A

This extract also serves to further emphasise a feeling expressed earlier, that the wealthy homeowners who, participated in this study, feel more inclined to use their PV systems (or install ones) to go off-grid than to engage with the municipality by joining the FiT scheme at these rates. This is not what the municipality wants, so it is an issue that possibly warrants more attention from policy makers and future researchers. The following extract indicates *Participant 3's* mistrust in the lack of clarity pertaining to how future, unintended consequences may be handled. This level of insecurity is not conducive to encouraging potential PV owners to invest in

embedded generation systems. Participant 3 eventually concludes that engaging with the municipality on electricity generation via the FiT is just not worth his while- indicating more evidence to support the claim that the participants, on the whole, found the FiT scheme to be unviable.

Participant 3: Also- I'm just a bit cautious that if sufficient people start feeding back into the grid- and Eskom can't sell it to you, they're going to institute a levy per household for you to have that facility to feed back and then it's not worth your while at all. Much higher than what it is now- where they see they are loosing out, they'll say: "I'm going to tariff you higher!" Or they put your taxes up, same kind of thing and eventually it's not worth your while.

Extract 23: Appendix A

This also shows that there is a very real tendency for participants to feel “cheated” by the FiT, because they were under the impression that the scheme was intended as an incentive to encourage them to install embedded solar PV systems. There was also the assumption made on the part of the participants that by installing an embedded solar PV system, they would be contributing to the energy security of the country. In the extract above, *Participant 3* goes on to express further concerns about the reactive nature of the policy and the lack of information for how the consequences of increased solar PV will be managed. This hints at the lack of long-term planning on the part of the municipality and very clearly shows how this breeds insecurity amongst residents and potential investors such as *Participant 3*.

The low FiT offered and the additional R140 grid connection fee provoked participants to such an extent that the scheme has lost credibility from their perspective. St. John (2015) shows that this dissatisfaction with the idea of fixed charges is rather popular. This is evident in *Participant 9's* declaration that he feels

“penalised” for wanting to do his bit to help (this is links in with the earlier expression of the expectations that participants had of making good money off investments in SSEG PV systems. This indicates the idea that participants potentially feel the need to be rewarded for contributing to the country or the environment or whatever it is they feel they would be contributing to by investing in SSEG PV systems. This is another indication of perceptions and mind-sets that need to be managed if SSEG or DG is to be promoted and possibly requires campaigns to illustrate plans that ensure any long-term environmental and financial benefits are enjoyed. The emphasis here is on *long-term* benefits). Evidence for this can be found in the extract below:

Participant 9: I think that if there is a message that needs to go back to the Municipality: I'm even happy to put the extra energy that I'm generating back into the grid for free to help the country- but don't – don't – Don't charge me a R150 to do my part for the economy- because each and every inverter you can set up that you should not export to the grid or that you can export to the grid, um, and I have less of an issue with the 60c that you want to pay me- its not cost reflective but I can live with that- but don't penalise me if I want to make my contribution- I feel like this is a penalising system- I mean the economics doesn't work for me to put it back into the grid but on top of that as well you want to penalise me by charging me R150 for the right to make a contribution- it just doesn't make sense...

[Murmurs of “hmm-hmm” and “exactly” from various participants]

Extract 24: Appendix A

The issue of pay back periods was also raised as participants attempted to find the potential benefits of the FiT scheme for them.

Facilitator: Ja and some electrical work to get going so that's more or less what the cost breakdown is and that's the other thing we need to understand around these systems, and I think we get into that here, um, ja and the question is: how many appliances can you run on each of these kind of systems and we're going to talk about the practicalities and get into some examples in a moment, but the point I wanted to make here is around calculating to define your finances around this: yes the PV panels themselves will last around 20 years, the inverter is going to last you 10 years, ok? You're typically going to need to replace that, and the batteries: if your really look after them very well, deep cycle normal deep cycle or lead acid batteries, will last you up to 5 years. So those are significant costs associated with it. Do you want to talk a little bit about the technical side and the cost of these systems...

Participant 10: Ja that gels with the costs at my place...

Extract 25: Appendix A

Participant 6: I just want to understand that 7-8 years pay back, (points to slide) is that assuming the ability to sell back into the grid or is that just for your on use?

Facilitator: Yes, that's what we've seen for our own use..

Participant 6: Oh so if you could sell back ...

Facilitator: It should be looking better now...

Participant 6: Assuming I can generate more than you use...

Facilitator: Ja

Participant 10: Ja, you can spend more also...

Extract 26: Appendix A

This discussion also ended in expressions of mistrust in the scheme given that the economics did not make sense. The research into calculating pay back periods is

also complex and no accurate method exists to date because of the infinite number of ways in which participants use electricity. This makes it very difficult to predict pay back periods and when the additional charge of R140 a month is taken into consideration, the idea that one will actually ever manage to pay off their embedded solar PV systems and enjoy proper savings on their electricity bill seems impossible to these participants.

Furthermore, predicting pay pack period and gaining data on average electricity consumption per household is not possible given that electricity consumption behaviour is influenced by human behaviour and human nature.

Facilitator: Ja the figures have been thrown around, my co-facilitator will also give you a hour lecture on that because in theory a third of your electricity consumption goes into heating water um, but we've seen cases now where that doesn't necessarily mean people reduce electricity consumption. We've had some strange cases where people install a solar water heater and then they say, "Great so now I can switch on my under floor heating..."

[Some participants laugh]

...So that's the nature of people. Um, but ja, I mean, the energy department its something they promote a heat pump that's driven by a PV system basically uh, with a big enough tank- so during the day you're generating and it can carry you through the night.

Extract 27: Appendix A

This quote gives a sense of the unpredictability of human behaviour because even when energy efficiency measures are taken, the expected results may not be experienced.

Finally, Participant 9 finally raised the issue of 'needs'. The quote below is important because *Participant 9* is attempting to close the gap between the proposed FiT scheme (solution) and 'the problem.' I have already shown that 'the problem' is

considered to be slightly different depending on whose perspective is used and therefore an alternative way of framing the problem could be useful. Identifying real needs from both the participants and from the municipality could be the first step in designing low carbon energy solutions that have the potential to provide more benefit than inconvenience to the different stakeholders involved.

Participant 9: Ja, so for me I think its almost interesting to know what you're optimising for because a lot of your bullet points speaks to storage- which is in my mind a little bit of a separate decision to: "Do I want to put solar panels on my roof?" Because, with a feed in tariff you can effectively say: "Ok well I want to use Eskom or the municipality as my battery," so you have a decision to make: why (if you want to consider a battery) why do you want to do it? Is it to safeguard your self against load shedding? Or is it to save money? Um and I think the economics of storage, whether its putting it into a battery or whether it's, at these rates, putting it into the grid, it's not economical. There is another reason why you want to do it so its either a lifestyle or an ethical driven decision. Um, I think where our velocity comes in is a battery is an expensive thing but a water tank that stores hot water is also a battery but it's a lot cheaper- so you really need to decide what are you solving for. Um, and then you need to design your solution specifically around those needs so I think if you have five people around the table, you have five different answers for what people are solving for. It's just interesting for me to see- it feels like there is quite a strong storage underlying component here, which, for me, is slightly separate issue from the PV decision.

Extract 28: Appendix A

Three fundamental needs emerged from this discussion from the participants include:

- The need to feel secure and confident in the design of logical strategies to promote energy security and RE development; the need for increased self-sufficiency and decreased reliance on the national

utility Eskom if it continues to prioritise dirty energy generation methods over investment in clean RE systems;

- The need to have a say in decisions that relate to them because quotes above indicate that these participants were very eager to send a clear message to the municipality: that the rates proposed are not acceptable to them; and
- The need to have their concerns about increasing electricity prices heard, and taken seriously, and for there to be long-term, low cost electricity solutions that they can invest in, provided it is clear how that investment will pay off over time.

From discussions with members of the Stellenbosch and CCT Municipalities, fundamental needs exist:

- These municipalities need for a more flexible financial model because of their struggle to be flexible and enable RE development without supporting policies and while being locked into the rigid municipal financial model and in order to engage in discussions to seriously take RE development seriously, they would need slightly more flexible model. There is evidence for this in the extract below:

Mr Jones: Ja! It is.. um a lot of people... you know there is no legislation... the electricity supply industry is highly regulated and you cant breathe without having some law telling you what you can and can't do and um, it goes back to the electricity regulation act and there is nothing in law which gives any direction as to how you handle small scale embedded generation and the National Energy Regulator has been working on a set of rules, um, and they should've been issued about a year ago or so... but they haven't been so we just felt that we had to put something in place from an electricity distributor point of view so that... to... sort of stem the flow of people connecting illegally to the grid- to Eskom's grid and to... throughout the country um so it is reactionary from a electricity perspective... um but the city also has a strong sustainability drive and um, and it has.. the city... from many different angles would like to see um... PV proliferate from the job creation point of view... and the economic benefits of that uh... from the climate mitigation point of view... um... uh, ja and from you know... kind of the green image of the city as a destination for investors is just multidimensional so you know there are challenges to electricity revenues as with energy efficiency and it kind of upsets the apple cart just in terms of the way scientific knowledge has been applied in the past to the distribution of electricity because all of a sudden you've got something that is completely unpredictable and um and really disrupts operations in many ways so... ja... it's been a big learning curve. It hasn't been resisted in any way but it has been, I would say a bit reactionary from ... or... ja. [pause]. And I would say "reactionary" because there hasn't been legislation in place to guide- you know?

TIME STAMP: 00:06:03

Researcher: Yes, it definitely seems like there is an idea of where we want to go, and then there's... who is it do you think who is driving the uptake of rooftop PV? Do you think its residents or organisations like Green Cape or...

Mr Jones: I think it's suppliers of PV equipment- people who are trying to make a living...

Researcher: And when you say “It [embedded solar PV systems] helps with energy security” is that despite issues of intermittency and the issue that you’re going to end up with a lot of electricity in the middle of the day...

Ms Wicht: Ja so... obviously rooftop PV doesn’t solve that issue because, it only becomes um, a solution if people put battery packs [i.e. if systems are not embedded] on and can charge the batteries, and use that energy in the morning and evening when the sun is not shining um, so so...

Researcher: And in terms of grid connected PV where systems are feeding back into the municipal grid and municipalities would end up with a large amount of electricity in the middle of the day- how would that energy be dealt with?

Ms Wicht: Um, uh, ja so it would be through redistribution through the municipal grid also, I know for example, the city is re-looking at... or putting together a whole demand side management strategy... so how can they try and shift those peaks, especially in winter because they present a huge problem for the city so they are looking at a whole lot of different...

Extract 30: Appendix B

- The FiT scheme (as it stands) is no more convenient for these policy makers than it is appealing to the participants of this study, however the municipalities still need to fulfil their mandates of providing affordable electricity to low income households as well as ensure electricity security to all users. In addition to this, these stakeholders also need to ensure that they are able to meet increasing electricity demands. Linked to this, these stakeholders also recognise their need to do *something* in order to keep up with RE generation, the idea of distributed versus centralised generation and RE technology developments because being ‘left behind’ appears to be a legitimate fear.

Mr Jones: So Cape Town's approach is conservative... I get concerned that we generally are power engineers, we're not modern cell phone app, data... and I think... I just get a feeling that we have to be very careful that we don't get overtaken like cell phone companies have taken away the business of Telkom. We have to be careful that we don't get caught like that but also not just run ahead and shoot ourselves in the foot by rolling out systems, which are premature.

Extract 31: Appendix C

This point is also evident in the quote below:

Ms Wicht: Um...I mean... I think ... the difficulty we face in South Africa is that because the energy system is so highly centralised, trying to decentralise that is a massive, massive challenge... um... however, um... the City of Cape Town for example, has started to look at what would the utility model of the future look like and trying to see well, does the city for example become an investor in PV and as a city- do they get involved in putting up a whole system that they feed into the grid for the city of Cape Town for example...

Extract 32: Appendix B

- Discussions pertaining to the requirements for increased administrative capacity, the need for a smart grid system to facilitate the management of embedded solar PV for more sophisticated billing systems, the need to facilitate market growth for solar PV in order to make it more affordable and the need to develop demand side management and public communications campaigns all represent the fundamental need for a more holistic approach that is required to adequately engage in the decentralisation of electricity generation and distribution at municipal level (Wicht 2016; Jones 2016).

ii. This technology is actually NOT that user friendly...

Consumers mentioned the many issues or challenges that they have faced while attempting to gain more information reliable installers and on the sizes and types of PV systems they might need. They want more information inform their decisions regarding investing in solar PV systems.

The first issue raised was that there is so much information that a potential solar PV consumer has to consider and much work to do to ensure that they select a reliable and reputable PV vendor, identify their electricity use profiles and needs correctly, understand all the technical information on system sizes, decide whether or not to install batteries and figure out how the system, once installed, actually works. The participants identify these issues, and the sheer amount of research that goes into making informed decisions on this topic as further potential barriers to the uptake of SSEG PV systems. More of these issues are explained in excerpts below:

Facilitator: Ja I mean, uh, the professional guys can come and look at your appliances and do an analysis for you, a reasonable, good exercise. Interestingly enough, as an example technically, I only found this out after we installed the system, is you can't switch in an electric lawnmower...

[Laughter all round]

Participant 1: What happened?

Facilitator: I was called out of a meeting to go home, and some of the electrical guys in the meeting said basically when you plug in a lawnmower, your system sees it as a short, which is not useful.

Participant 3: Have you got batteries on your system?

Facilitator: Yes

Participant 3: ...And it still can't get the lawnmower going?

Facilitator: It's a physics issue, that it sees it as a surge.

Participant 3: Oh, so a pool pump it can manage but not a 2kW lawnmower?

Facilitator: Inductive motors it can't handle...

Participant 3: Well a big one. A pool pump is also inductive, but its much smaller...

Facilitator: So, I mean this is something else that you've got to consider and one learns as you go along. To [Participant 10's] point now, earlier on, I mean so, why would you consider a system like this? I want to get your views... I mean you're all here, so you're interested.

[Extract 33: Appendix A](#)

Solar PV systems are not simply “plug and play” systems and this can be off-putting to many. Further research is required into the extent to which this presents an issue or a barrier to uptake amongst a more representative sample of homeowners in Stellenbosch.

Many participants felt that not everyone would go to such extremes to install a PV system unless they had a vested interest to do so. This is possibly an area where a

public communications campaign could lend support. The validity of the need for a more holistic approach to the uptake of solar PV systems is further strengthened as well. Mr Jones further emphasises the extent to which potential consumers feel that knowledge is not easily available. He is the head of RE of the CCT Municipality and he is also struggling to work out what to do in his capacity as a homeowner who is potentially interested in investing in a SSEG PV system:

Mr Jones: I don't know... um, I think a similar kind of barrier, and I think that this is what you're looking at is I haven't got a solar water heater and I haven't got a heat pump, and I have a price for a heat pump but we also don't have a swimming pool, we've got 4 people living in the house, two teenagers and we're using less than 600 units a month, so I don't think we're going to make a huge amount in savings by putting in a solar water heater and just from a financial point of view you know? But if I wanted to put in a solar water heater, do I know what kind of solar water heater? Do I want to put in a flat plate or tube or coupled or decoupled or do I want a closed coupled...? I don't know? Or a heat pump? I don't know...! And and, and we know that some units don't last so long and you've heard of units that don't work properly and sometimes people hear about a success story but normally people don't talk about the success stories, they talk about the failures so... and I'm a technical person, you know so... you've got a housewife... uh... who is a non-technical person... house-father, whatever, husband... [laughs]... you know... how do you make a decision and every, every supplier you're talking to is telling you "no no no, that's nonsense, that guy is lying to you... my stuff is the best" – How do you know what to choose?

[Extract 34: Appendix C](#)

This is also illustrated by the fact that the participants who showed up were all people who either had a particular interest or career in electricity generation or green energy, those who had already installed solar PV systems, or, those who had already begun the process of researching what they need.

4. Ethical, environmental, and social considerations

i. Accessibility of policy

The policy released by Stellenbosch Municipality (2016a): the guidelines for small scale embedded generation in Stellenbosch Municipality 2015/2016, is inaccessible to the general public on two main levels: accessibility to the information and the policy itself, and in terms of its relevance to the majority of the Stellenbosch population.

Apart from being made available on the Stellenbosch Municipality website, the actual policy document was not announced and the participants were not aware that it had been released. The first they had heard of it was in the focus group discussion. This is the first issue with regards to the availability of the policy.

The second, more serious issue with regards to the availability has to do with the fact that the policy, intentionally or not, caters only for the rich and simply does not mention any relevance to, or consideration of, the majority of the Stellenbosch population. This is problematic because the municipality's resources are not being used to meet the actual needs (providing a secure and sustainable electricity supply at low cost and with minimal impact on the environment) of the majority of the population.

A major critique of the current study is that the research, due to time and resource constraints, could only include one focus group, of one socio-demographic group. This is mitigated somewhat by the fact that I have aimed to use this constraint to open doors for future research opportunities that could probe for more in-depth information about whether people from different demographic groups have different perceptions on the topic of embedded generation or not, and into why certain participants decided to attend this focus group while others did not. Furthermore, a detailed study can be conducted into the different electricity needs and priorities

amongst members of different demographic, age and gender groupings because, as noted by *Participant 10* in the extract below, the conversation that emerges could be very different to the current discussion.

Participant 10: I think one thing you must just recognise is that we're a privileged audience: you and I and other guys who install systems here can go *gunghoe* to install a system that is nice and big and has excess power... most people actually will still draw all the time from Eskom, they are just really optimising their system to take the peaks out...

That might be a different discussion: While those guys clearly wont put in excess power... so we have excess power... but I think they're in the minority- most people wont have excess power- they'll have to invest to have excess power.

Facilitator: But still, the minority can make a, can potentially have a HUGE impact for the municipality.

Participant 10: Yes, but not in terms of feeding back.

Facilitator: No.

Participant 10: Just taking less.

Participant 1: Just getting off the grid.

Extract 35: Appendix A

This section shows that accessibility of this policy to the public is limited on two levels. First, public engagement is limited, as only those who would have known about the policy could have seen its release for comment. Participants expressed their lack of engagement with their municipality via the website and mention that they would have missed it if not for this focus group. The second level is that the policy is simply not relevant to the majority of the Stellenbosch population. This is problematic because it serves to perpetuate inequality and causes the municipality and researchers to miss out on potentially interesting and insightful discussions with

potential participants from lower LSM groupings unless further research into this issue is conducted.

ii. The involvement of women

The pie chart on gender provided above depicts a clear picture of the harsh reality that women, for the most part, did not attend the focus group discussion. Further research could be conducted into why this was the case. I have described (in chapter 2 as well as in section 1 of this chapter) how the participants were gathered for this study. Briefly, emails inviting participants to attend were sent to the JRA mailing list. Perhaps a contributing factor to the lack of woman in attendance could be that that they are not part of the mailing list- potentially indicating the effects of more structural sexism..

Comments by various male participants in this study also indicate a gender divide between men and women where energy consumption issues are concerned. The first comment made, for example, implies that women in *Participant 10's* family have no concept of the cost and value of electricity and so do not engage in electricity conscious behaviour- such as saving but instead are wasteful in their electricity consumption.

Participant 8: Why are you using so much electricity?

Participant 10: My wife baths a lot.

[Laughter all round]

Participant 8: Must be a lot hey.

Participant 10: Ja, I know...

[More laughter]

TIME STAMP: 01:03:07

Participant 8: It's about saving.

Participant 10: My family doesn't have a sense of what power costs... I just keep my fingers in the dam wall.

[More laughter]

Extract 36: Appendix A

A second comment made by Mr Jones implies that women may not be interested in the technical aspects of electricity generation and consumption, while men find tinkering around with technology far more appealing.

Mr Jones: And people love to hate something, and they love to hate bureaucracies and they see that Eskom CEO is getting R40 million bonus and they decide no- they are going to go off the grid because, you know, its kind of not a rational thing, its an emotional thing so, uh, I think guys particularly like gadgets and... I'm not saying women don't but... there is kind of a sexy gadget aspect to having a PV system- people like tinkering around with it... and it's a real interesting aspect to getting something like that going, you know?

Extract 37: Appendix C

While this echoes some well-known stereotypes about the difference between men's and women's interests, it is also worrying because there are many more aspects involved in sustainable electricity reform, in addition to the technical aspects. Pearl-Martinez & Stephens (2016) highlight the currently limited role women play in renewable energy transitions as compared to men and call for a stronger emphasis on the involvement of women in this field because, they argue, it is important for RE transitions (for sustainable development) to promote gender equality now otherwise it may be more difficult to do so later. The United Nations (UN) also emphasises the point that women are largely excluded from household energy consumption decisions, and that it is, however, women who generally have more direct involvement in household energy consumption and should therefore be more involved in household energy decisions (UN Women 2016). A study to reveal the opinions and potential contributions that women in residential areas have towards the energy related issues in South Africa could be extremely useful to design campaigns to encourage the participation of women in planning and design of RE solutions.

The discussion revealed that the participants shared a sense of concern for the environment and that this concern does play a role in informing their decisions for installing solar PV systems. A key finding here, however, is the need expressed by these participants, particularly by participants 1, 2, 8, 9 and 10 was the need to feel like they were part of something bigger- a bigger plan that they could put their financial resources towards in order to promote environmental wellbeing while meeting their investment needs.

This concern first emerged when the discussion on whether I would be better to manage load shedding with a diesel generator or with a solar PV system.

Facilitator: We are busy with a new study for our faculty with diesel generators and so on. The other issue is when we had load shedding a lot of people went off and bought diesel gen-sets right, now they are standing idle there now for the last year, and you're supposed to start a diesel gen-set every month and so on otherwise- it goes haywire. So it's a lot cheaper obviously, but it's a sunken cost into something that you don't get continual benefit from...

Participant 8: What's the cost of generating electricity through a generator?

Facilitator: Uh, about R3, 60 per kWh.

Participant 10: Even more I guess

Facilitator: Ja, well it depends on the diesel price.

Participant 8: And an unhappy neighbour

[All laugh and nod in agreement]

Extract 38: Appendix A

In this excerpt, concern is expressed for the local environment that is as important as concern expressed about the broader environmental condition- relating to climate change. This finding is useful because it can be researched in more detail and built into future approaches for sustainable energy design.

5. The role of knowledge dissemination

The results have highlighted a common issue that extends throughout each theme discussed above: the importance of greater levels of knowledge sharing to promote the sustainable uptake of RE, particularly SSEG PV systems. This was an important point raised in the literature review as well (Deshmukh et al 2010; Odarno et al 2015 & Domenech et al 2014).

Participant 4: I think that one of the things we haven't spoken about is on knowledge: if knowledge would make a difference to the uptake of this system, the problem is there is so many possible solutions- if you had 3 or 4 solutions for the problem then its easier to distribute the knowledge- to get information. But with this whole situation- you actually have to get to know your own specific needs are.

Facilitator: Ja I mean in that sense a gen-set is so much easier- you go and buy a gen-set and you buy fuel and you're set but you still need to know how much you're going to use to size your diesel gen-set- now here like you said there is storage options here, different technology configurations... makes a little bit more complicated.

Extract 39: Appendix A

This theme briefly emerged earlier on as well, in terms of how it potentially represents a barrier to the uptake of SSEG PV systems in South Africa. I provide further evidence for it here because it is a point that was raised more than once by the participants themselves. This quote shows that some participants feel overwhelmed by the seemingly infinite number of solar PV options that are available on the market from the various system sizes and capabilities to the various options for storage and grid connection as well as the behaviour and lifestyle changes as well as the energy efficiency retrofitting options available. The participants also, like Jones (2016) mentioned that they felt they did not know whom to trust with the installation of their systems and call for greater municipal support in this regard.

Participant 1: So maybe the number of vendors isn't the issue but they're...

Participant 10: You must pick the good ones.

Participant 1: The accessibility is still the issue...

Participant 10: Ja but if you find guys who need to come and you can find a good guy with a good reference.

Facilitator: Ja, as you say, I don't think the issue is finding someone to come and install but after- I think this is so much more important here in terms of after sale service. Uh I mean like [participant 10] says... I mean I love playing around with my system but I mean, I'm an engineer you know, but that's not what everybody is going to do. You just want to plug and play and get on with it. And that.... [Jumbled voices speaking over one another- inaudible].

Participant 5: And then you expect the system to run on its own.

Participant 10: But it doesn't. They need to come back a few times to adjust some of the set points for charging and how deep to cycle the battery and, he knows all about that, [indicates participant 8], they don't come. That's the issue.

Extract 40: Appendix A

It was concluded that perhaps a way of managing this problem is: the Stellenbosch Municipality could organise a list of reputable vendors in the same way that the CCT provided guidelines to assist homeowners in making decisions regarding the installation of solar water heaters. I wonder, though, whether this is likely to be provided, given that I have shown that there is some evidence to suggest Stellenbosch Municipality and the CCT have not designed their FiT schemes with the intention of incentivising the uptake of embedded solar PV systems...

i. Did consumers' opinions change after the information and discussion sessions?

While I have shown the potential importance of information dissemination for promoting the successful and sustainable uptake of RE systems, careful thought needs to go into how the information is structured and presented to ensure it encourages the desired response. The renewable implementation strategy also needs to be coherent because, as the participants demonstrated, there was a tendency to question the logic behind the proposed FiT (or other RE strategy) and one cannot assume that information alone will be enough to promote an illogical strategy.

In this case, the knowledge dissemination section of the focus group was intended to provide participants with an understanding of the policy, the context from which the policy was developed, and of the potential opportunities that the policy change and FiT could offer them. A short questionnaire was designed to gain a sense of the levels of interest in installing an embedded solar PV system amongst participants and was administered before and after the discussion.

The key finding from these questionnaire results was that “ignorance is bliss” and that interest in learning about and installing an embedded solar PV system actually dropped after the details of the FiT scheme were presented and discussed.

Participant's Interest in Being Able to Generate their Own Electricity for Personal Use as well as to Sell Back to The Grid

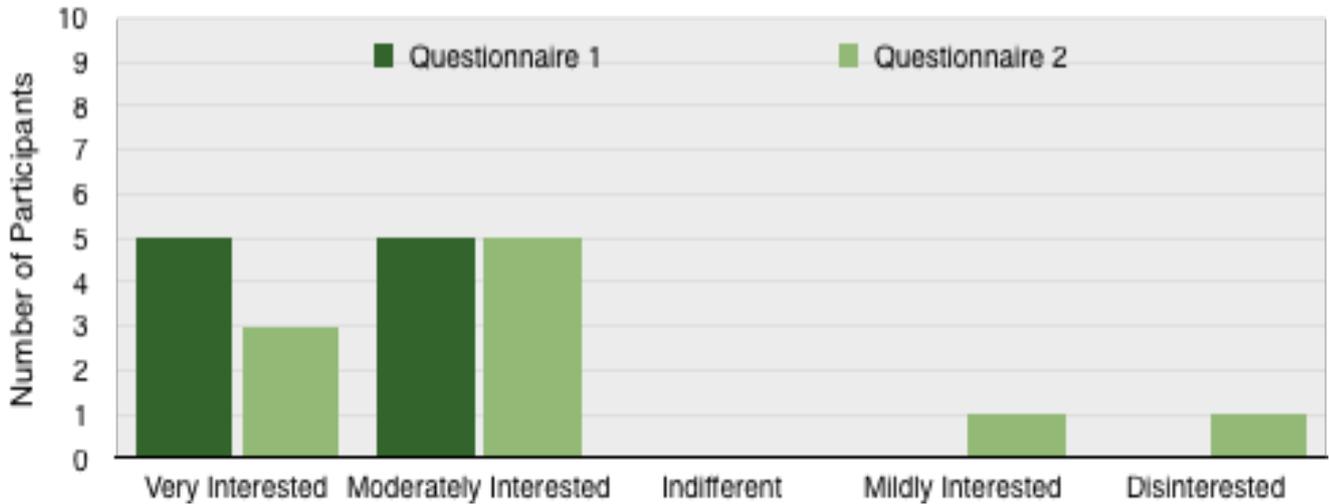


Figure 24: Participants interested in generating their own electricity and feed-back to the grid.

This drop in interest could be attributed to the fact that participants felt that they now knew what they needed to know in order to make a decision. It could also be attributed to the dissatisfaction expressed towards the proposed FiT scheme. Mr Jones' put it very well:

Mr Jones: Ja well that's my gut feeling is that um, when you know that you don't know, you become cautious, but when you don't know that you don't know, you... off you go! But when you know... doesn't mean you stop.. it just means that you're cautious so maybe the time that you took that second survey, um... was half way through that process and people have got to assimilate that, and think about it and check it and so on- it would be interesting to redo it a couple of months later, with the same people to see how things have changed now. Then they were probably feeling overwhelmed and sort of hunkering down...

Extract 41: Appendix A

d. Conclusion

The thematic analysis of these voices has revealed that there are mixed feelings regarding embedded PV expressed by all the stakeholders consulted for this study.

The participants support the idea of SSEG PV from an environmental perspective; however, their support is limited because of their dissatisfaction with the FiT scheme on offer. Further key findings are listed below:

- Participant dissatisfaction emerged because the FiT scheme does not appear financially viable to them, nor does it meet their financial needs and expectations.
- There is evidence for a lack of trust in the scheme because it is considered reactionary (rather than proactive) and does not provide clear guidelines for how the unintended consequences of grid connection would be dealt with. Participants are weary that because of this lack of organisation and consultation on the part of the municipality (in this case the Stellenbosch Municipality), a financial burden in the form of various tax or levy increases may be piled on them in order to manage any unintended consequences.
- Participants express a lack of trust in the extent to which the municipality is genuinely offering them an incentive and promoting green development.
- Participants express a preference for a more business savvy approach that possibly involves a more open electricity market. They are interested in having the option of having wheeling agreements, however they do not consider any long-term consequences of this idea for other stakeholders, such as the less wealthy or the municipality

- Participants' attitudes towards the municipality include contempt, mistrust and frustration where the issue of embedded PV is concerned, and many of them would prefer to go off-grid (if possible). Again, they express this preference with only limited consideration of the unintended consequences that may exist for themselves and for other stakeholders included in the Stellenbosch Municipal electricity system.

The policy makers' perceptions and aims differ depending on whether the stakeholder is a representative from provincial or municipal government. While the two municipal stakeholders interviewed essentially communicated that the issue of embedded PV presented financial and administrative burdens on already struggling municipalities, the stakeholder from provincial government insisted on the promotion of the uptake of embedded PV for the potential benefits regarding the development of a green economy for the Western Cape. This indicates a problematic clash of objectives within the government system as well.

Overall, from the three sets of stakeholders that I engaged with (participants, municipal government and provincial government), there exist three sets of perceptions, aims and challenges to the practicalities of enabling embedded generation. These three sets of views stem from three different perceptions of 'the problem' that is in this context. The primary issue that emerges from these results is a distinct lack of opportunity for transparent communication between all three sets of stakeholders to develop coherent, common understandings of the problem that each would aim to address. As a result the roles that each should play towards the management of the problem are unclear and each side remains alone, struggling against a mountain of policy constraints and judgement from the other. This is not conducive to the successful uptake of embedded PV (if that even is the most useful way of managing the challenges raised in these findings).

While different stakeholders have different perceptions of the problems that embedded PV is intended to address, there are also different expectations of the

technology that are informed by their different reasons for engaging with the idea of embedded PV. These differences ultimately lead to clashes of objective and are largely due to limited communication between the policy makers themselves, as well as between the policy makers and the public (in this case, the focus group participants, and, in the case of the clash of perspective, between the two levels of government described above).

The analysis also reveals that the clashes in objective can also be attributed to the different approaches to electricity development that inform decisions taken by policy makers, that I described in chapter 1. These approaches include the social development perspective and the business perspective. This clash in objective can be damaging to initiatives and campaigns that, on the surface, appear to enable embedded PV, but in reality offer limited benefit, thus provoking some extreme responses from participants. There is evidence to suggest that information dissemination has a role to play in managing these differing perceptions, objective clashes and unmet expectations, but ultimately, a more holistic approach, beginning with a more rigorous research process to develop coherent and common understandings of the problem, could prove more useful for guiding future work for enabling small-scale embedded generation in South Africa.

The next chapter looks at sustainability and complexity theory, as well as what other researchers have found, to make sense of the research findings. The discussion aims to develop a picture of what an alternative approach could look like in the Stellenbosch context, and, presents avenues for further study that could yield useful information to inform future decisions for DG and sustainability.

5. Chapter 5: Discussion

This chapter focuses on the triangulation of the findings from chapters 3 and 4 with the relevant complexity and sustainable development theory that is provided here. In this study, my overall aim was to triangulate (i) the results of my case study with; (ii) the theoretical lens through which I have decided to view the complexity of the electricity transition in South Africa; and (iii) findings from the literature review investigation into the various approaches taken towards the uptake of DG elsewhere in the world. This study therefore aimed to (i) assess the extent to which the drive for the uptake of PV systems can be considered able to contribute to a transition for a truly sustainable electricity system in South Africa's future; (ii) provide recommendations to policymakers; and (iii) identify opportunities for future research.

a. The Theory

1. What is 'sustainable development'?

In the definitions section (before chapter 1) I provided a brief explanation of my interpretation of the concepts of "Sustainability" or "sustainable development." This term is often associated with ideas of all things "good" and "green" and has often been quoted with intentions of simply green-washing fundamentally unsustainable practices (Pindela 2014). Alternatively, the concept is also sometimes vaguely interpreted and used without the proper engagement with the strong ethical component of the concept (Hattingh 2001; Swilling & Annecke 2012). Because ethics are involved, there are many interpretations of the concept of sustainability, which in itself, is a fairly new concept (WCED 1987). The theory and perspective of complexity also prioritises the use of ethics to add to our understanding systems in general because it reveals that in order to understand any information gained from the study of complex systems, we need a framework for interpretation, which,

according to Woerman & Cilliers (2012), should include ethics. Using a combination of insight gained from sustainability and complexity literature will provide new ways of understanding and dealing with the complex energy systems at municipal scale (with reference to Stellenbosch Municipality and results from this study) and of managing the wicked problems that exist therein.

Below I provide a brief history of the development of the concept and explain its meaning, from my perspective, with relevance to this study.

The concept of sustainable development emerged from a need to have a global platform on which to discuss the increasing recognition of global social and environmental issues as well as resource limitations such as: the degradation of the ecology and ecosystem services, limits to natural resources such as land and fossil fuel and, social inequality and poverty that all are becoming increasingly difficult for governments all over the world to manage effectively. Some of the key authors, whose works form the theoretical structure for the field of sustainability, are: Mebratu (1998), Hopwood et al (2005), Sachs (1999), Rockström et al. (2009), Hattingh (2001). Swilling and Annecke (2012) explain that the integrated global crises form part of what Edgar Morin (1999, 73) describes as the global “poly crisis” that emerged over time, though our species’ increased and insensitive exploitation of the planet and of each other in the name of “progress.”

Hopwood (2005: 41) provides a visual representation of how the approaches to sustainable development can be mapped out in relation to each other. He also explains the difference between the extent to which each approach calls for “strong” or “weak” sustainability, where weak sustainability promotes the status quo or simply a ‘greener’ business-as-usual approach, and strong sustainability calls for more radical paradigm shifts to promote social, political and economic transformation. There are also less extreme approaches that Hopwood et al (2005: 41) describe as “reform approaches” that represent somewhat of a middle ground between what the current situation is, and what is ideal. Reform approaches are

shaped by what is realistically possible at this point in time, given the policy, economic and social contexts of the initiative for sustainability.

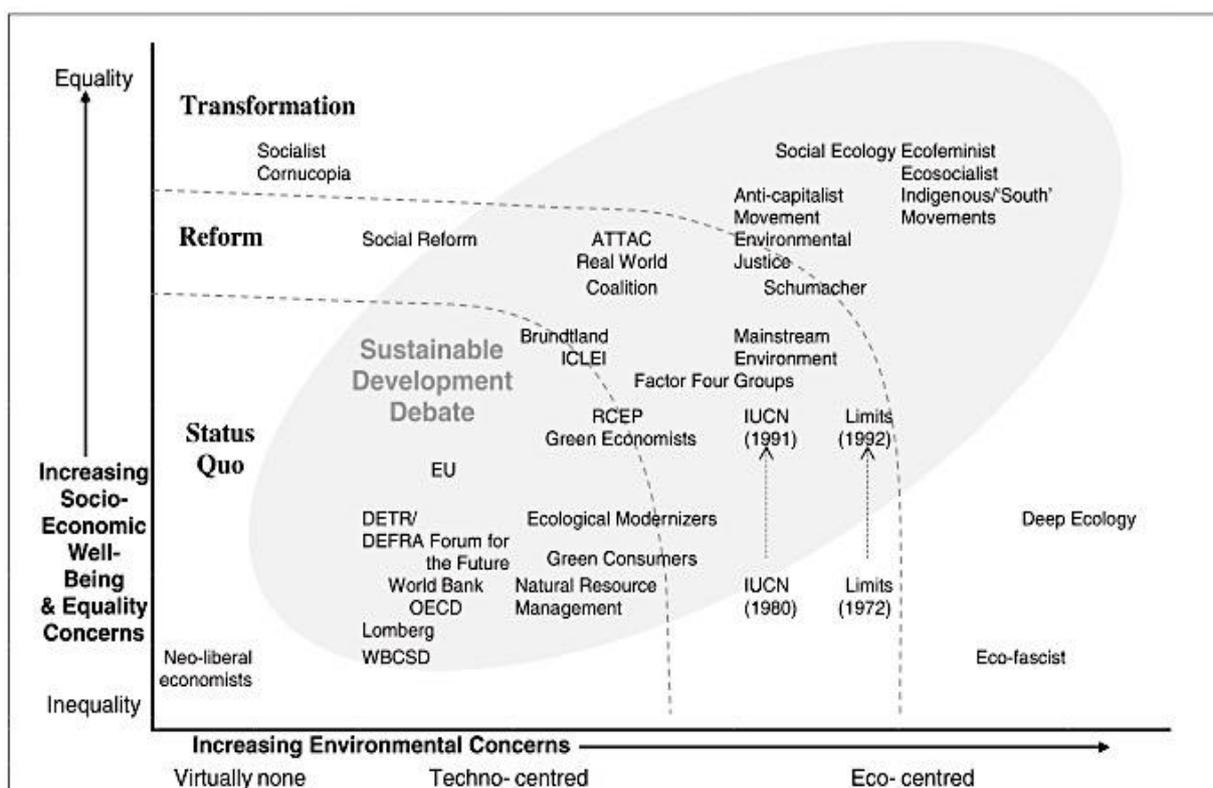


Figure 25: Different approaches to Sustainable Development (Source: Hopwood, B.; Mellor, M. & O'Brien, G., 2005)

There is therefore no “correct” or generally accepted approach for how to practically implement sustainable development ideals. Neoliberal market approaches encapsulate the most conservative approaches to sustainable development and have virtually no consideration for attempts to alleviate environmental damage or promote wellbeing. Many of the other Status Quo approaches also rely on the idea that advancing technology will assist humanity to alleviate or possibly even undo the environmental damage done and sustainable development is simply a matter of promoting the uptake of such technology. The problem with this approach is that people use technology and their behaviour is

essentially unpredictable – meaning that technology alone cannot save the planet. Advances in human attitude and thinking are required to understand and use such technology in ways that can increase the chance that the potential benefits of the technology are realised. The more radical the approach, as shown in the diagram above, the more environmental wellbeing and shifts in human thinking are prioritised.

Sustainable development itself is an ambiguous concept. According to the oft-quoted Brundtland Report, sustainable development refers to “... development that meets the needs of present generations without compromising the ability of future generations to meet their needs” (WCED 1987: 43). This Report first brought the term: *sustainable development* into the political sphere at the World Commission on the Environment and Development (WCED). This commission highlighted issues of ecological degradation, inequality and poverty and the attempted to reconcile economic and environmental goals while prioritising the importance of human needs (Mebratu 1998; Hattingh 2001). This is where the issue of need also first emerges. The aim of these policies was to ensure an equal, sustainable distribution of the earth’s resources to improve the quality of life of people in developing countries as well as to maintain the high standards of living for people in developed countries (Hattingh 2001).

This definition, although well intentioned, is ambiguous and problematic because it popularised sustainable development that has allowed “... business and governments to be in favour of sustainability without any fundamental challenge to their present course, using Brundtland’s support for rapid growth to justify the phrase ‘sustainable growth’ as a justification for actions that do not really promote ‘sustainable development’ (Hopwood et al 2005: 40). Banerjee (2003) further argues that the very term ‘sustainable development’ is contradictory when one looks at the meanings of the two irreconcilable terms: ‘sustainable’ and ‘development’. To ‘sustain’, according to Banerjee (2003: 158), has connotations of nourishment and support in the long term whereas ‘development,’ [and related, limited, but

popular notions of ‘progress’] he argues, is “...an act of control, often a programme of violence, organized and managed by nation states, international institutions and business corporations operating under the tenets of modern western science.”

Gallopin (2003) provides a more recent understanding of ‘sustainable development’ that implies more radical change is required. He defines sustainable development is development that is not dependent on ‘material growth’ and where progress or growth is monitored using measures for quality of life rather than quantities of resources consumed. This radical change first requires the recognition of the vast social inequality that has resulted from society’s prioritisation of material growth (based on capitalism and social exploitation). Second, a paradigm shift that questions the mainstream assumption that quality of life is always and directly linked to increased consumption and material wealth is needed in order to inform alternative approaches to development and growth that do not result in the exacerbation of the *global polycrisis* (Gallopin 2003; Morrin 1999: 73).

Allen et al. (2016) provide another, more radical, interpretation for how the concept of sustainable development can be interpreted to gain understandings of how transitions could work in reality, with a particular focus on sustainable development in urban contexts.

This perspective is also informed by ideas from complexity theory and systems thinking. Allen et al (2016) assert that “...cities provide unique opportunities for sustainability-oriented innovations that address equity and ecological challenges...” and therefore that urban areas are key areas of focus for sustainable development projects, however they caution that these processes are unlikely to be controllable. They therefore describe these spaces as “untamed urbanisms” and explore the extent to which attempts to “tame” these environments are useful in transitions for sustainability. The call for stronger governments with improved planning strategies for resource management, for example, is identified as one such attempt to tame untameable urbanisms and suggest that this strategy is limited because of the

reflexive and unpredictable nature of human thought and behaviour. Allen et al. (2016) venture to take the acceptance of complexity a step further and suggest that "...heterogeneity [diversity of actors] is [not] a symptom of state failure... in fact it might reflect the realities of highly complex untamed urbanisms that will need to be gathered together not into a new institutional uniformity, but into institutional assemblages that are profoundly relational, negotiated and therefore always provisional..." They also acknowledge that this could be considered unnerving to many.

I chose to introduce this idea to this study because it has implications for my applied research analysis provided in this chapter, particularly when I attempt to provide recommendations for policy and other decision makers. There is a tendency to want to call for stronger, more integrated and directed government intervention. This perspective also alerts me to the fact that while ideal, this may not be practical yet. This perspective therefore provides a way of **tempering the ideal situation with the reality of context.**

This discussion shows that the concept of 'sustainable development' is highly debated and when one aims to support or facilitate 'sustainable development', it is important to ascertain what exactly is meant. It also shows that there are no approach widely accepted as 'correct,' and that guides all practical implementation of initiatives that promote sustainable development. While the Brundtland Commission called for stronger political intervention to direct processes towards sustainable development (WCED 1987), Allen et al (2016) call for stakeholders to embrace the complexity of processes for the implementation of initiatives for sustainable development and accept a multitude of these diverse processes that do not depend upon or are not restricted by government attempts to control and unify the process through policy alone. It is unclear at this stage, which will prove more successful. Swilling and Annecke (2012) make a strong argument for the facilitation of local level initiatives for sustainability championed by dedicated individuals who prioritise stakeholder engagement for the definition of needs and objectives and to

create fundamental ownership and support required to increase the chances of success for the initiative. This is coupled with transdisciplinary research that provides a way of practically implementing transitions for sustainable development based on the principles and understandings of complexity theory. Each initiative is facilitated in ways that take the context of the initiative into consideration and therefore a single roadmap for this approach is not provided. This approach is similar to that suggested by Odarno et al (2015) as it prioritises the recognition of complex problems and the need to **manage rather than “solve” them.**

In light of the ambiguity of the concept of and the multitude of approaches towards sustainable development that are taken, The United Nations Environment Programme (UNEP) has attempted to provide more clarity on the topic and has defined a set of 17 Global Sustainable Development goals (UNEP 2015b). The aim of these goals is to guide global practice towards the design and facilitation of sustainable development because of the seemingly infinite number of ways it can be defined, interpreted and used. These goals (Figure 23) are extremely broad but represent the ideal standard of achievement in each area of development (e.g. energy, agriculture, social equality, economic development, education and so on). Unfortunately, there are no guidelines for how the UN can ensure compliance with these goals and as a result, they remain suggestions rather than concrete guidelines for direct action.



Figure 26: The 17 Sustainable Development Goals (Source: UNEP 2015b)

These goals are pictured in Figure 23 as being separate to one another, but in reality they are integrated and show that environmental wellbeing should be prioritised to the same degree as human wellbeing and is, in fact, a prerequisite for human wellbeing. When you click on the “affordable and clean energy” icon, it reads: “ensure access to affordable, reliable, sustainable and modern energy for all” (UNEP). “...*For all*...” is key here because it directly contradicts policies that enable only the rich to benefit from RE systems - as is potentially the case in South Africa’s proposed efforts to regulate the uptake of SSEG systems (particularly small-scale embedded solar PV systems). The concept of sustainable development is now discussed in terms of the South African context.

In South African policy, sustainable development is predominantly used to refer to the process of aligning goals for social and economic development with goals for promoting environmental health in order to tackle the “triple developmental

challenge of poverty, unemployment and inequality” (Montmasson-Clair 2012: 5). Although quite progressive, this understanding of the concept is more in line with the Bruntland definition of sustainable development than with the more radical interpretations.

Below is a list of South African policies that show both the consideration of the integration of goals as well as the direction in which plans for transitions towards a green economy and sustainable development are moving. These are mentioned because they have influence over, and relevance to, the development and RE spaces in the South African context. As a reminder:

- The New Growth Path (2010) that includes targets for job creation and renewable energy generation (Brent et al 2012:27);
- The Integrated Resource Plan projects the amount of energy required in the future and what proportion of this will be supplied from RE generation (Brent et al: 27);
- The Industrial Policy Action Plan (IPAP and IPAP 2) and South Africa Renewables Initiative that aim to secure funding for renewable energy projects, support development projects that mitigate climate change, create space for private sector involvement and cooperation for projects that support the development of a greener economy (Brent et al 2012: 27).
- The National Development Plan (NDP) (2011) that aims to move South Africa away from the unsustainable consumption of resources and promote efforts to reduce carbon emissions while promoting economic growth (Brent et al 2012: 27)

These show that national level policy makers have given some consideration to sustainable development ideals, however, there is no guidance for their practical

implementation at local level, especially for local renewable energy development. My interpretation and understanding of the concept of sustainable development is more in line with Gallopin's (2003) definition. It involves the recognition of the 'global polycrisis,' as described by Edgar Morin (1999, 73) and the idea that more deliberate and radical paradigm shifts and transformations are required if we, as human beings, wish to ensure the long-term survival of our species as well as that of our planet. The knowledge that authors such as Paul Cilliers (2008 & 2006), Johan Hattingh (2001), Swilling & Annecke (2012) and Rockström et al. (2009) among others generate is what has informed my understanding of sustainable development. These authors also argue for the use of approaches to applied research and knowledge generation that provide ways of acknowledging and engaging with, rather than trying to simplify and control, notions of complexity that emerges from interactions of actors within systems.

A key challenge involved in the concept of sustainable development is that, because it encompasses various imaginings of what sustainable futures could look like, a formal and widely agreed upon 'roadmap to sustainability' unfortunately does not exist. In addition, there is the notion that the design and implementation strategies to promote transformations towards an idea of 'sustainability' need to be highly context specific. I do not seek to define such processes either, because doing so would be near impossible given the complexity and dynamic and reflexive nature of human interaction and behaviour and the context specific requirements of each attempt at implementing the idea of 'sustainable development'. However, I agree with Hattingh (2001), who determines that these processes, in whatever form they take, need to be governed by ethics and through processes that involve facilitation and stakeholder consultation. This is because the issue is not merely that sustainable development promotes transformation, but that the transformation is 'just' and does not continue to perpetuate patterns of exploitation and inequality (Swilling and Annecke 2012).

2. A brief introduction to Systems Thinking

Scientific thought on systems developed slightly ahead of modernity (a paradigm founded on a reductionist approach to science) and was led by Ludwig von Bertalanffy (1950: 23) who developed the 'Theory of Open Systems in Physics and Biology'. This is an alternative to reductionist thought and Newtonian science forms part of the foundations for the paradigm shift towards the postmodern movement reference. This is an important part of this theory that informs the decisions made in this study because it indicates that I do not subscribe to approaches for sustainable development focusing on maintaining the *status quo*, but instead aim to highlight the need for an alternative approach.

This alternative scientific theory considers all living and non-living things as parts of broader systems. Meadows (2009) identifies three characteristics of a system: A system is made up of elements/parts or components that are self organised and interact dynamically with one another to perform a function. The relationships and interactions that occur between the elements within a system and between systems are considered more important than the reduction of the system to its most basic elements. Each element making up a system can also be made up of smaller elements that form part of a smaller system.

Living systems, according to von Bertalanffy (1950), are open systems. These are systems that interact with and are affected by changes in other systems as well as the broader environment and energy flows through these systems to maintain life and allow for the existence of emergent properties. They function to maintain the stability of the system and work towards but never achieve equilibrium. Closed systems do not interact with the environment and become static once equilibrium is reached and static is synonymous with the death of the system. (Bertalanffy 1950). Clayton and Radcliffe (1996) build on this theory by emphasising the need to recognise the limits or thresholds of a system, which if crossed, disrupt the balance

of the system and lead to collapse. This can have disastrous consequences for other, interrelated systems (Clayton & Radcliffe 1996).

This thinking recognises that the world is made up of systems at all scales that interact dynamically with one another. It also influences approaches to sustainable development in various ways, as explained above and forms the basis of the more radical approaches

This is relevant to note because the case study results reveal the extent to which decisions and actions taken in one system have direct and indirect effects on others to which it is connected, or within which it is embedded. The decision (from local governments such as the Stellenbosch Municipality) to enable a FiT, for example, is a direct response to homeowners' tendencies to connect their PV systems to the grid illegally. Conversely, the decision to enable a FiT has been received negatively by the focus group participants who may choose to adjust their behaviour accordingly (either connect their systems to the grid anyway or focus their efforts on going off-grid completely). At a deeper level, the focus group findings have revealed that improved communication between the various sets of stakeholders may be beneficial for the design of alternative process that promote the uptake of such renewable energy systems that prioritise deeper sustainable development goals over shallow financial incentives.

3. From systems thinking to Complexity Theory

“Complexity is a characteristic of a system” (Cilliers 2008: 44) that cannot be ignored in the field of sustainable development. This is because on a philosophical level, complexity theory and systems thinking offer the basis of a third paradigm that could provide a way forward from the on going debates between the paradigms of modernity and postmodernity.

Cilliers (2008) explains that the essence of complexity is inaccessible- it cannot be extracted from a system but arises from the interactions between the elements of a system. Cilliers (2008) provides the basic characteristics of complexity: complex systems include many heterogeneous elements that interact in rich, dynamic and non-linear ways and that self organise to perform a function or change to adapt to changes in the environment. This interaction results in emergent properties that are lost when the system is broken down. Complex systems are also open systems that exist within larger (and can simultaneously incorporate smaller) systems (Cilliers 2008). The acknowledgement of complexity is therefore the acknowledgement that it is not possible to know and understand everything about a system (Preiser & Cilliers 2010). These ideas have been shown to reflect in the more radical approaches to sustainable development as explained above.

Roberto Poli (2013), Paul Cilliers (2006), Edgar Morin (2007) provide insights on complexity and on ways in which it can be used to deepen our understanding of systems.

Roberto Poli (2013) makes the important distinction between two types of systems: complicated systems and complex systems. Complicated systems can be analysed and understood from a reductionist perspective and complicated problems that form within the system can also be permanently solved.

For example a car is a complicated system- one can understand how it works by breaking it down and if there is a problem one can take it apart, find the problem, replace the broken part and put the whole car back together again and the problem will (hopefully) be solved.

Different methods are required to analyse and understand complex systems because these systems are self-organising and have the ability to change and adapt in creative ways in response to other changes within the system or its environment (Poli 2013). A human body for example, relies on the fact that it remains in tact,

with all the parts functioning together, in order to support the human life. Unlike with the car, one cannot pull the entire human body apart and expect to be able to fix a problem, reassemble it and have a living patient by the end. Complex systems therefore cannot be reduced to their basic elements to be understood because the process of reduction destroys the emergent properties (the 'life' in the example above).

This shows that the broadening of science is necessary for knowledge generation from a postmodern perspective and to compensate for the shortcomings of modernity and reductionist science. Systems are better understood because their complexity is acknowledged and more energy is directed towards understanding systems and a whole rather than breaking them up (Poli 2013).

In order to use complexity to improve our understanding of systems, and to gain different kinds of knowledge from, and about systems, I return to Cilliers (2000) and the debate about knowledge. This is relevant because it lays the theoretical foundation and provides reasons for the recommendations for future research that I will make later.

To avoid falling into the trap of relativism, Cilliers (2000: 8) maintains that we can understand knowledge as arising from the dynamic interactions between the elements of complex systems rather than being generated from the reduction and analysis of the parts. Cilliers (2000) shows that both subjective reality and reality that is external to the subject (data) exist in a complex system. Therefore knowledge and data are separate things.

The data in a complex system refers to the system's history and its context that influences the nature of the interactions in the system's network.

Knowledge arises from way in which the subject experiences and learns from their experience or interactions with other elements and, importantly, how it chooses to

give meaning this information. The perspective of complexity therefore shows that the world is far more complex than the reductionist thinking of modernity allows for, and provides a new way of understanding what knowledge is and how it is generated within systems. New understandings of knowledge also influence our involvement with systems and this chapter aims to show how this insight can be applied to the interpretation of case study results and can be used to make recommendations for policy and decision makers as well as for future researchers

4. Relevance of sustainability literature and complexity theory to case study findings

Complexity theory therefore emphasises the importance of interaction in complex systems. This can be extended to the importance of interactions between people, policy and technology in complex, municipal energy systems, such as the one described in the case study of chapter 4. The focus group results show that management of the interactions between stakeholders has largely been neglected. Ms Wicht (2016), from provincial level government, and the Energy Game Changer project have identified this lack of engagement and have, through their research that I mentioned earlier, attempted to gain insight into consumer attitude towards SSEG PV in order to inform the design of a communications campaign. Ms Wicht (2016) therefore aims to actively promote the development of a repetitive communications campaigns to encourage people to take more energy efficiency measures and to promote the uptake of PV systems.

The research approach taken by the Energy Game Changer, into why people are not participating despite the FiT, is therefore valid, however, from a perspective of complexity, one could argue that this proposed solution (a communications campaign) might only enjoy limited success. The perspective of complexity emphasises more participatory processes for managing how actors behave in a system. The results pertaining to information dissemination in the focus group, presented in chapter 4 also suggest that communication, and information

dissemination may not necessarily have the desired effect. For example, I expected participants to be keener in engaging with the idea of SSEG PV if they knew more about it, however, the opposite turned out to be true. Communications campaigns need to design their message and proposed action very carefully. I prefer to suggest a more participatory approach be taken to research in this context, however, because the approach emerges from insights gained from interaction and the approach would be more flexible and able to accommodate change. This is because the hope is that participatory research processes emphasise engagement with all stakeholders to determine needs and to discuss their responses to suggested interventions instead of designing the intervention in isolation, applying it at a large expense, and then having to investigate why it was not as successful as was hoped.

The question of what is considered 'successful' is also up for debate in the absence of a participatory process because the focus group results also show that each set of stakeholders has a different objective.

In this particular case, the stakeholders from Stellenbosch and CCT Municipalities may consider themselves 'successful' because the FiT was not received well amongst the participants (or the Drakenstein community) and did not serve to incentivise the uptake of embedded PV. The stakeholders from the Energy Game Changer project, on the other hand, consider this a failure because their priority is to enable the development of a green economy for the province by promoting the uptake of a technology system and facilitating market development for it. This is a neoliberal approach, because market behaviour and the uptake technological solutions to environmental problems are prioritised over goals for social equality and does not engage with ideas for more radical, political and practical change for sustainable development, and should therefore not be marketed as anything other than the neoliberal approach that it is, by policy makers or PV retailers. This is because marketing these objectives were shown to provoke negative responses from participants who did not buy into the marketing strategy of promoting PV with a FiT for financial and environmental benefits and the responses showed that the lack

of trust that emerged served to further alienate the potential consumer from the FiT scheme, and from their local government. Further research is required to assess the full extent of the response and its consequences but, thus far, it is evident that it has not resulted in market growth for solar PV technology, let alone served to promote the achievement of the country's sustainable development goals set out in the national policies mentioned above.

The consumers also simply aimed to make money off the scheme and hoped to possibly do their bit for the country (and the environment) on the side. These objectives are also highly problematic because they don't show true consideration of, or commitment to promoting sustainable development or the recognised need to promote social equality in their community. This shows that there is little interest, on the part of the participants, to engage more widely in discussions for sustainable development as well. There was therefore no pressure on the other stakeholders at municipal and local government level to prioritise other objectives such as the promotion of environmental well being and the implementation of climate change mitigation strategies.

This reveals the need for a paradigm shift amongst electricity consumers as well as amongst decision makers and suggests a path for future research: to develop and conduct research that can contribute to such paradigm shifts in society over time. A useful communications campaign, from this perspective, would be one that is directed at spreading information and awareness of the goals for more ethical sustainable development and on the more responsible behaviour required to achieve those goals- particularly around responsible resource consumption behaviour. This is because the need for sustainable resource availability and environmental well being are needs that are relevant to every individual and, when coupled with financial needs as well as needs for electricity security (expressed in the focus group), they could, together, form fairly strong motivators for more responsible behaviour and more creative, sustainable electricity generation and distribution

practices. Further research is required into the extent to which these findings from the focus group can be applied to other contexts is, however, required.

A strong quote comes to mind from Master Sun Tzu (Cleary 1988: 43) who wrote the Art of War (in this case I draw parallels with the war on climate change and unsustainable development): “*The way: means inducing the people to have the same aim as the leadership, so that they will share death and share life, without fear of danger.*” This piece of ancient wisdom is perhaps, on the surface, a little extreme for the current discussion, however, the message is clear: without common aims, there is little chance of cooperation and can decrease chances of survival for all involved. The interpretations of this quote emphasise the use of humane and considerate techniques to win the hearts, minds and loyalty of *the people*, adding that including them in the definition of the aims and realisation of the benefits is key to encouraging their support.

There is also, however, a need for the recognition that the perceived gap between the government and the participants (and homeowners in general) is problematic and that actually the government (especially a democratic one such as ours) exists to serve the people. This implies that the ‘people’ also have a responsibility to direct the calls for the type of development they need. This is in line with the suggestions made by Swilling and Annecke (2012) to include public participation for transitions towards sustainable development and more specifically, Odarno et al’s (2015) emphasis on the inclusion of participatory processes in the planning stages as well as on consumer consultation in the following stages of the design and implementation of distributed generation systems.

The results of the case study are now presented in order to answer the questions posed in chapter 1 with reference to the theoretical perspectives on sustainable development and complexity theory described above. The sub questions are answered first before a discussion to answer the main question is provided.

b. Answering the research questions**i. What do participants think about the idea of investing in PV systems for their homes?**

The results show that all ten participants initially showed great interest in the idea of investing in PV systems for their homes. The interest was enhanced by the prospect that their investments could be made more attractive by the newly enabled FiT scheme from the Stellenbosch Municipality. The interest soon turned to feelings of frustration with the government when it became clear that the FiT did not, in fact, have the potential to make their investments more attractive in the long term. Participants particularly had an issue with the idea of the grid connection fee of R140 per month. They argued that they would not save enough electricity at the current tariff that they pay, nor feed enough electricity back to the grid, to make up for this extra R140 per month payment. This payment, in their minds at least, leads to increased pay back periods that makes the investment in rooftop PV unviable. The interest then turned to a discussion of batteries and the costs involved in storing electricity and whether or not PV was the most viable option. Some participants expressed keen interest in investing in PV systems with batteries in order to go off-grid completely and thus decrease their reliance on the municipality for the provision of electricity.

ii. Is embedded PV with a FiT something participants specifically need or want?

Some participants indicated that this technology is something that they would want. They expressed that they would want PV to decrease their electricity bill or to have a FiT to make investing in the technology more affordable. Still others mentioned that PV with batteries is useful during load shedding so as not to have to deal with the inconvenience. These are wants, however, and not necessarily 'needs' because these participants can easily afford access to grid-supplied electricity and have

access to the grid. The needs that were expressed were for cheaper electricity in the long term as well as needs for access to secure and green electricity – also in the long term. I have shown that there is no guarantee that SSEG PV is capable of meeting those needs due to policy uncertainty. More research is therefore required into how to meet the needs expressed by participants and to determine the extent to which similar needs are expressed by other communities and socio-economic, gender, culture, and age groupings.

iii. Do participants understand the costs and implications involved in becoming more energy independent?

On the whole, the majority of the participants did have a fairly accurate idea of the costs and financial commitments involved. At least two participants had already installed PV systems in their homes and several others had begun the challenging process of researching their electricity needs and costs to inform their decisions on whether or not to invest. All the participants intended to find out more about the FiT scheme, in the hope that they would stand to benefit financially.

iv. Why would they consider investing in a solar PV system? If not, why?

The results presented in chapter 4 show that there were several reasons why homeowners were considering the investment. These included: to save on their electricity bill by supplementing their own use; to have back up power during load shedding (if systems had batteries); for vague environmental reasons and to have increased control over their electricity supply and consumption. The motivations for potentially participating in the FiT scheme were primarily the idea that there was the possibility of financial benefit. The other reason why participants said that they might consider it is to help the country meet its electricity supply needs (even though there is no evidence to show them that these benefits would actually be realised). One participant mentioned that he would gladly do this, even at the low rate of the FiT offered, if the R140 grid connection fee was dropped.

v. Do the participants like the idea of having a feed in tariff and would this make them more partial towards investing in a PV system?

Not at the proposed rates, the answer to this is a definite no.

vi. What effect would the process of providing homeowners with more information on the costs, implications, benefits, drawbacks and opportunities have on their attitudes or opinions towards the idea of investing in rooftop PV systems?

This is difficult to answer, because attitudes and behaviour are difficult to predict. Further research based on systems thinking and complexity theory as well as greater efforts to conduct consumer engagement and participation could shed more light on this issue. The results showed that the dissemination of information on the FiT scheme served to alienate some participants from the idea as they realised that it was not as beneficial as they had originally thought. This cannot wholly be blamed on the focus group information dissemination process, however, because it is possible that participants would have come to this conclusion independently anyway. Participants also made a call for greater community engagement and for the provision of more information in order to inform their decision-making processes honestly and clearly and to enable them to make the investment more easily if they decided to go ahead with the commitment.

I suggest that greater participation in planning and increased consumer consultation could pave the way for more robust, diverse distributed generation solutions that aim to cater for shared, rather than individual need and promote more sustainable development of the electricity system.

c. Triangulation of findings

Now that I have answered the sub questions, I turn to a discussion that provides answers to the main research questions that informed both the case study and the literature review and how information gained here can be used to assess the effectiveness of approaches to DG and SSEG in South Africa as compared to elsewhere.

As a reminder, the main research question posed was: *What do residents in Stellenbosch think about the idea of investing in PV systems for their homes with a feed in tariff that enables them to sell their excess electricity back to the local municipality?*

The short answer is that participants strongly rejected the FiT scheme on the grounds that it was not economically viable for them, primarily because of the R140 fixed monthly grid connection fee that is included. Their irrational anger towards this aspect of the FiT scheme somewhat overshadowed the fact that, apart from the R140 monthly fee, they did not really have a problem with the actual suggested FiT itself (the Eskom rate + 10%). Participants also felt frustrated with the municipality for having suggested such a shallow scheme given the depth of the national electricity crises that they have experienced over the last few years and that they expect to experience in future. They therefore think that the scheme is inadequate and that they are possibly better off going off-grid if they can afford to end their engagement with the Stellenbosch Municipality. Whether or not any of them actually will, remains to be seen. The damage to the relationship between the participants and their municipality has, however, been done and any attempt to repair it would require an increase in transparent communication between the two (and possibly an adjustment of the R140 grid connection fee IF municipalities decide to seriously start incentivising the uptake of SSEG PV. Further research is also required to determine whether this finding can be generalised to any degree or not.

Interestingly, the research findings that emerged were richer than what I had expected them to be and have actually opened up many more doors for future research of the Stellenbosch electricity system. The discussion also provided insight for why consumers rejected the FiT scheme and provided some understanding of their perspectives on electricity-related issues in South Africa. In addition, insight was gained into which of these issues participants felt ought to be prioritised and how they felt these issues could be better managed. This therefore provides insight into what participants expect from municipalities and ‘the government.’ These expectations differed to the Stellenbosch Municipality’s, leading to the clash of objectives that requires further research. This research can be conducted into the identification and merging of needs, the need for more coherent understandings of the problem and the issue of accessibility to of sustainable energy investments or participation from a greater portion of the community including women and those who are less wealthy (refer to chapter 4 for a more in-depth discussion on each of these topics).

More research and communication from a more holistic perspective informed by sustainability theory as well as by perspectives of systems thinking and complexity is required to realign the objectives with the UNEP Sustainable Development Goals (2015b) or at least for the national goals for sustainable development outlined in the NDP (DoP). This is necessary because the complex problem, as explained in the background section of chapter 1, runs deeper than issues of who stands to make financial gains in the short and long term. The survival of the planet is essentially at stake.

d. The effectiveness of approaches to DG in SA as compared to DG elsewhere

Finally, a discussion on how the South African approach to SSEG compare to approaches taken elsewhere in the world is provided to show that the South African

approach needs to be broadened. This is according to the results of the case study and also in comparison to approaches revealed in the literature review on international case studies

Generally speaking, the results from the Stellenbosch case study reveal that the relevant stakeholders in South Africa have chosen to take an approach to distributed generation that prioritises SSEG PV systems. This is similar to some approaches taken in the UK, Italy, Malaysia and Germany. The findings that emerged from both sets of case studies (chapters three and four) show that all these countries face similar challenges in how to develop a FiT scheme that is affordable to each relevant government (and viable for the population) and that is also able to successfully facilitate the opening of a sustainable solar PV market. Both Italy and the UK have experienced failures in this regard, particularly in attempts to successfully open sustainable solar PV markets to enjoy all the related benefits to increased PV uptake. Whether or not Malaysia (whose socio-economic context is most similar to that of South Africa) will succeed with their financing mechanism, remains to be seen.

The literature review showed that countries that took more radical approaches towards the development and uptake of DG and RE systems, and that were more flexible in the type and variety of systems used, tended to enjoy more success in terms of implementing user-friendly, sustainable energy solutions. These countries included Peru, Costa Rica, China, Kenya and Zambia. In Zambia, Kenya and Peru the RE and DG systems proposed were mainly implemented in rural areas where there was no access to grid supplied electricity and these systems were essentially meeting basic energy needs. While Costa Rica, Brazil and China have all also experienced challenges with facilitating embedded generation and with developing FiT, these countries have all taken more determined steps towards increasing RE uptake in order to meet local energy needs, and the global need to reduce carbon emissions and combat climate change. More detailed information on the Costa Rica case study is provided below to further illustrate this point.

Costa Rica has, as of April 2016, also introduced a net-metering scheme that allows PV system owners to use the grid as a battery. Instead of earning a FiT for feeding excess electricity back to the grid, participants in the scheme will earn credits that they can spend on electricity at a later stage (for example, at night when their PV systems are inactive) (Pomareda 2014; Arias 2016). The stakeholders also acknowledge that the net-metering system suggested is inaccessible to lower income households (who are actually most in need of ways to reduce the portion of income spent on electricity). There is evidence that the stakeholders in Costa Rica have considered this challenge and are looking into approaching banks to develop revolving financing schemes to increase access to RE technologies, such as embedded solar, to lower income households (Pomareda 2014). Another interesting point is that embedded generation options are not restricted to embedded solar PV systems but extend to wind and biomass generation as well, and that regulations have just been released by regulatory agency: ARESEP. This shows that Costa Rica is effectively using consumer consultation processes to develop and enable more flexible solutions for embedded generation based on the identification of needs and commitments to meet those needs. Costa Rica therefore remains a stronger example, or point of reference for South Africa in our attempts to open distributed generation markets and for promoting sustainable development as both countries are ultimately managing the similar challenges that face developing countries in general.

The strong similarities between the more successful implementation of DG and SSEG have therefore been shown to be: increased consumer consultation and engagement of stakeholders to determine and find ways of meeting needs. This lends credit to Odarno et al's (2015) ten suggestions for things to consider when designing and implementing DG and SSEG projects with greater chances of success. The challenges faced by countries engaging with DG and SSEG that have emerged from this discussion are now discussed in terms of how they compare to the challenges that emerged from the case study context in Stellenbosch, South

Africa to show that these problems stem from the limited approaches taken towards SSEG and DG in different contexts.

- **A lack of consumer consultation and public engagement** at all stages of design, planning, implementation and follow-up of DG projects that lead to slow and unsustainable market development and system uptake (Antonelli & Desideri 2014; Ondrazek 2013; Deshmukh et al 2010; Lillo et al 2015 & Muhammad-Sukki et al 2013). This was also a key concern raised by the analysis of the case study results presented in chapter 4. The lack of consultation had resulted in the emergence of several different perception of what the needs and challenges were and resulted in different objectives and ideas for how they should be managed.
- **Poor integration of different objectives in planning and policy** for example aligning objectives for social development with objectives for better environmental practice as well as with objectives sustainable market development and future grid upgrade and expansion (Antonelli & Dersideri 2014; Urpelainen 2014; Ondrazek 2013; Ahamad et al 2015; Han et al 2016 and Liu et al 2013). This was also a strong theme that emerged from the results from the case study conducted in Stellenbosch.
- **A lack of target setting and development of mechanisms to define and monitor progress** towards the achievement of objectives as well as poor development of short-term goals and targets from larger long-term goals. For example, many countries have targets for the reduction in carbon emissions and increase in renewable energy generation capacity but few countries detail exact plans, with short-term milestones, to guide implementation progress on the ground. All the aspects that DG implementation could benefit or affect are also not always taken into consideration (Ondrazek 2013; Antonelli & Desideri 2014; Muhammad-Sukki et al 2013 and Deshmukh et al 2010). It was revealed, through interviews with provincial and municipal policy and decision makers, that there are no targets

or monitoring programmes suggested to guide the uptake of DG and SSEG in the Western Cape and especially not in Stellenbosch. This is exacerbated by the findings that emerged and that indicated that some of these stakeholders did not support the scheme for various reasons, further revealing the municipal aim to be to disincentivise a rapid increase in the uptake of these systems. The negative responses to the proposed FiT from the focus group participants indicate that this aim could likely have been achieved- prohibiting progress of any kind towards sustainable electricity development in the municipality.

- **A lack of proactivity, research and creativity** used when DG projects are designed, often resulting in the implementation of DG projects and related training and capacity building programmes that do not meet consumer needs or fall within the bounds of what is affordable to consumers (Lillo et al 2015; Holderman et al 2014; Deshmukh et al 2010; Koh & Lim 2013). This theme also emerged from the case study in chapter 4 with municipality employees admitting freely to taking conservative, limited approaches because they are unsure of what else to do. This indicates not only a lack of policy guidance from national government but also a lack of research and knowledge of other options for enabling the uptake of SSEG in the Stellenbosch area. Coupled with this are the existence of fear of unintended (and some unknown) consequences, and the limited perceptions of potential benefits that could be managed through further research inquiry informed by more useful perspectives such as complexity theory and informed by sustainable development goals, as UNEP suggests.

- **The development of mistrust amongst consumers and other stakeholders** felt towards government and electricity utility when policies have negative consequences or change at short notice in reaction to market or consumer behaviour due to the short-term, reactive approaches taken to policy planning in some cases (Mienaar 2016; Muhammad-Sukki et al 2013; Cherrington et al 2013; Antonelli & Desideri 2014). This is similar challenge that emerged in the South African context because although inspired by a different set of circumstances,

mistrust and frustration clearly emerged from the analysis of the focus group results and remained a dominant theme throughout the discussion. The lack of communication between all the stakeholders and the resulting clash of objectives has not served to inspire investor confidence and the feelings expressed by the participants show that they feel alienated from the Stellenbosch Municipality.

- **The problematic structure and design of existing electricity infrastructural, social and economic systems** that presents all sorts of technical, social, political and economic barriers towards the design, implementation and/or uptake of DG technology (Wilder-Ramsing & Potter 2008; Ondrazek 2014; Holderman et al 2014; Koh & Lim 2013; Melheri et al 2013; Han et al 2016, Liu et al 2013). In the Stellenbosch (and broader South African context) this issue has presented strong barriers towards the uptake of DG and SSEG systems. Some countries, such as Costa Rica and China have been more successful in their attempts to manage this than others, such as South Africa, Italy and the UK. This research shows that more genuine commitment to sustainable energy practices that include renewable energy systems, by all stakeholders involved is required if South Africa is to make any progress towards opening DG in the country and opening sustainable markets for RE technologies.

From this analysis, a general need emerges for more integrated research and therefore for a more holistic approaches that need to be taken to increase for DG and SSEG implementations to have increased chances of success. The South African approach revealed in this case study is no better or worse than any other attempt revealed thus far, but it also shows that there is considerable room for improvement. South African energy policy and decision makers could consider approaches taken by other developing countries such as Kenya, Peru, Costa Rica and China, when realigning electricity development goals with sustainable development goals to promote social equality, affordable energy security and environmental healing. I therefore conclude that the approach to enabling SSEG revealed in the Stellenbosch context, and used elsewhere in south Africa at

municipal level, is useful to some extent because it will serve to regulate grid connected PV practices but is also extremely limited in the potential it has to promote true (rather than shallow) sustainable development practices and the design of sustainable, clean, renewable energy generation and distribution systems.

e. Personal reflection and conclusion

“If you don’t know where you are going... any road will take you there...”

- Mom

This is something my mother used to say to us when we were growing up. Later, I learned that she would say it to her staff as well as a reminder of the importance of knowing what you want and how to keep yourself on track to succeed. While it was meant to inspire, I also secretly felt a pang of anxiety every time I heard this said out loud. As a member of generation Y, a millennial, fortunate enough to have been raised in the information age and confronted by infinite choice on a daily basis, I often felt like I had no idea what I wanted... lost amid a sea of possible futures with no roads in sight. My successful academic career, based on decisions driven by personal interest has ultimately led me here, to my desk, attempting to write a masters thesis. Completing the MPhil course in Sustainable Development has been one of the most challenging (and rewarding) projects I have done. One of the most influential aspects of immersing myself in sustainability literature is that it has helped me grow and realised that the idea of ‘not knowing’ need not be so stressful after all. Instead it could be encouraging because when both a lack of clarity can be an opportunity to design.

In the same way that I am lucky enough have the opportunity to be able to design my own life’s journey, according to my values, interests and needs, I believe that the study in the field of sustainable development potentially opens opportunities to

design alternative paths of resource management and consumption to all stakeholders involved.

I suggest that while promoting embedded solar PV systems at residential scale is a movement that has a place in the DG discourse in South Africa, more research (particularly into consumer needs and opinions) is required to enhance incentives, broaden the scope of beneficiaries and highlight the need to ensure the achievement of benefits from increased uptake. I also suggest that a broader perspective on, and research into the opportunities for DG systems and/or smart mini grid systems that could exist in the South African context (for upper, middle and lower income areas) can fill the void left by the realisation that perhaps there has been an overestimation of the potential and role of embedded solar PV systems in managing electricity-related challenges South Africa.

This study therefore combined knowledge from various avenues of enquiry (including personal reflection) and aims to serve as a starting point to guide future research in this particular direction, for once we have developed similar (or at least cooperative) understandings of the objectives, more detailed research can be conducted into the details of how the objectives could be achieved, how they can be financed and what policies need to change to be adjusted to enable them to be successful.

6. Chapter 6: Recommendations and Conclusion

a. Recommendations

This final chapter provides the recommendations and conclusion of this report. The recommendations are divided into three categories: recommendations for policy and decision makers, recommendations for future researchers, and recommendations for the Sustainability Institute and Stellenbosch University.

1. Recommendations for policy and decision makers

This set of recommendations can be classified as recommendations for the short term and those for the long term.

The most important short-term recommendation would be for policy and decision makers in Stellenbosch to conduct further research into the opinions of residents on the FiT scheme from a wider group of participants to determine whether the opinions that surfaced in this study are common. Second, and based on this further research, I recommend that policy and decision makers reconsider the fixed R140 grid connection fee because this is what the participants of this study were most unimpressed with. Municipalities are perceived as being one and the same with the ‘government’ and ‘Eskom’, and there is an opportunity here for municipalities to improve their public relations and communication with their residents and separate themselves from these perceptions. This could increase cooperation and improve the responses to municipal schemes, communications campaigns and policies from the broadly negative ones currently experienced – that is, if municipalities decide that there will be genuine commitment towards finding clean and sustainable energy solutions for their communities. This leads me to the more long-term recommendations that have emerged from this study, for policy and decision makers.

From the review of case studies of DG applications in different countries, I noticed that many of the challenges to the successful uptake of DG systems (and to the opening of sustainable markets for these systems), that were raised by the authors of each case, were similar. As a result, many of the recommendations provided by each author (or each set of authors) were also similar, and often had much to do with advising policy and decision makers to take more inclusive and multifaceted strategies to improve the chances of success for the uptake of DG and SSEG PV systems. I have also highlighted that similar suggestions were made to increase the chances of success in terms of facilitating sustainable market development for these systems as well. My recommendations to decision makers are therefore in line with what Odarno et al (2015) suggest, because these authors provide an overall structure of what such an alternative approach may look like, as well as a more practical set of structured questions that policy and decision makers could use to guide their development of alternative approaches for the inclusion of DG and SSEG PV systems into their local distribution networks and for facilitating sustainable market growth in these areas. This structure is provided in the table below.

Table 5: Guiding questions for policy makers. Adapted from Odarno et al (2015: 29-30).

Question no.	Question	Action questions	Key actors who should be involved
1	How are the objectives of DG efforts being established?	<ul style="list-style-type: none"> ▪ How clearly articulated are the direct and indirect objectives of the distributed generation effort? ▪ How clear are the links between distributed generation efforts and other development goals? ▪ How are choices made between competing priorities? ▪ How inclusive, transparent, and effective is the process for stakeholder participation in the identification of objectives? 	<ul style="list-style-type: none"> ▪ Relevant ministries ▪ National planning agencies ▪ Local planning agencies ▪ Development agencies
2	How are consumers	<ul style="list-style-type: none"> ▪ How are consumers involved 	<ul style="list-style-type: none"> ▪ Relevant

	being engaged in DG efforts?	<p>in the planning processes?</p> <ul style="list-style-type: none"> ▪ How well articulated are the consumers' roles and responsibilities in the DG effort? ▪ What capacity-building programs exist for consumers? ▪ What processes exist to ensure that the concerns of women and marginalised groups are captured in consumer-engagement efforts? 	<p>ministries</p> <ul style="list-style-type: none"> ▪ National planning agencies ▪ Local planning agencies ▪ Community groups ▪ Banks
3	How are long-term technical, institutional and other capacity requirements for DG being considered?	<ul style="list-style-type: none"> ▪ How have the specific capacity-needs for planning, developing, operating, and maintaining the DG project under consideration been identified? ▪ Who is responsible for capacity building and how effective have they been in fulfilling their role? ▪ What community/local capacity-building programs exist? ▪ How accessible are financial resources for capacity-development programs? 	<ul style="list-style-type: none"> ▪ Relevant ministries ▪ National planning agencies ▪ Local planning agencies ▪ Community groups ▪ Banks ▪ Donors and lending institutions
4	How are environmental and social considerations being factored into DG planning?	<ul style="list-style-type: none"> ▪ How are environmental and social impacts associated with DG projects considered and accounted for in project planning? ▪ How effective is the process for impact assessments, including environmental and social impact reviews? ▪ How are impacts communicated? For example, through official documents, websites, media and/or public hearings? 	<ul style="list-style-type: none"> ▪ Relevant ministries ▪ National planning agencies ▪ Local planning agencies ▪ Environmental agencies
5	How are DG targets being established	<ul style="list-style-type: none"> ▪ How are DG targets established? 	<ul style="list-style-type: none"> ▪ National planning agencies

	and monitored over time?	<ul style="list-style-type: none"> ▪ How well do targets reflect supply conditions as well as present and future energy demand profiles? ▪ What baselines and indicators are used to track progress toward stated targets? ▪ How effective is the process for monitoring and evaluating stated targets? ▪ How inclusive, transparent, and effective is the process for stakeholder participation in the monitoring and evaluation process? 	<ul style="list-style-type: none"> ▪ Local planning agencies
6	What policy and regulatory provisions are being considered to create an enabling environment for DG?	<ul style="list-style-type: none"> ▪ How clear is the policy framework for DG and how it is made accessible to the public? ▪ How do policies and regulations encourage and support DG development? ▪ How clearly has the role of the regulatory agency in the regulatory process been articulated? 	<ul style="list-style-type: none"> ▪ Relevant ministries ▪ National planning agencies ▪ Local planning agencies ▪ Regulators
7	How are investments in DG being financed?	<ul style="list-style-type: none"> ▪ How well known and explored are the available financing options for DG? ▪ How effective are subsidy structures and disbursement processes for DG? ▪ How effective is consumer financing for DG? ▪ How are DG projects linked to development sectors and productive activities? 	<ul style="list-style-type: none"> ▪ Relevant ministries ▪ Regulators ▪ Banks ▪ Donors and lending institutions ▪ Private investors
8	What ownership approaches can be used successfully	<ul style="list-style-type: none"> ▪ What kinds of DG ownership models have been used successfully in the project 	<ul style="list-style-type: none"> ▪ National planning agencies ▪ Local planning

	for DG implementation in your country?	context? <ul style="list-style-type: none"> ▪ What are the advantages and disadvantages of the different ownership and delivery models in the project context? ▪ What types of concession provisions exist and how well are these provisions understood 	agencies <ul style="list-style-type: none"> ▪ Utilities ▪ Private sector ▪ Community groups
9	How is DG being integrated into national power sector planning?	<ul style="list-style-type: none"> ▪ How effectively does your national electricity planning framework integrate both on-grid and off-grid options? ▪ How publicly accessible are national planning frameworks? ▪ How well integrated are long-term national priorities with short- or medium-term electrification planning goals? ▪ How clear are the roles and responsibilities of actors in DG implementation (national utilities, independent power producers, and communities)? ▪ How inclusive, transparent, and effective is the process for stakeholder participation in the planning process? 	<ul style="list-style-type: none"> ▪ Relevant ministries ▪ National planning agencies ▪ Local planning agencies ▪ Regulators ▪ Power producers
10	How flexible and responsive is DG planning to changing conditions in your country?	<ul style="list-style-type: none"> ▪ What mechanisms are in place to monitor and respond to changes in energy demand over time? ▪ How clear and effective are policies for transitioning from DG if the central grid arrives? ▪ How effective are processes for the periodic review of tariffs? ▪ What safeguards against unanticipated policy and regulatory changes exist? 	<ul style="list-style-type: none"> ▪ National planning agencies ▪ Local planning agencies ▪ Regulators

My key recommendation to policy makers is therefore to consider incorporating some of the points offered above, into plans for increasing the uptake of SSEG PV systems and in their efforts towards opening sustainable markets for these systems wherever possible. I also suggest that, wherever possible, the Stellenbosch Municipality (and any others interested) could take a more proactive, creative and committed approach towards researching and incorporating ideas for the uptake of other types of DG systems into their energy planning discussions. This is because, in light of the state capture report and the imposing, potentially bankrupting nuclear deal, creative, genuinely green, clean and workable examples of sustainable energy solutions are required if we are to combat further attempts at unsustainable development – that Eskom, the country, and the planet simply cannot afford (Labson 2016).

2. Recommendations for future researchers

The true merit of this research lies in the avenues for future research that it has opened and that I have alluded to throughout this report. I provide these research suggestions to promote the generation of knowledge that can assist policy and decision makers to make decisions for sustainable, clean energy developments and to provide information to enable policy makers to take a number of points suggested by Odarno et al (2015) into consideration. Future research can be conducted in order to:

- Investigate ways to design and conduct more participatory decision-making processes in the Stellenbosch context and into which stakeholders need to be included. For more information refer to Fouché and Brent (2016) and Odarno et al (2015).
- Investigate alternative structures of municipal financial models to allow for greater flexibility to accommodate the uptake of local DG systems and SSEG PV in more economically beneficial ways.

- Expand this study: I have shown that further research is required into the opinions of Stellenbosch residents from various racial, cultural and socio-economic groups in order to determine true energy needs and opinions of RE, DG, SSEG PV, and the FiT.
- Increase and encourage the inclusion and roles that women can contribute and play in the discourse of renewable energy and SSEG PV in Stellenbosch (and elsewhere). First, this group was marginalised in this study and the reasons for this need to be determined in future research. Second, having their input will be useful in defining the collective understanding of the multifaceted nature of the problem and designing collective, long-term solutions. Their input should be encouraged.
- Uncover the true energy and electricity needs of residents and stakeholders, and incorporate long-term, sustainable ways of meeting these via clean renewable energy (or hybrid) solutions.
- Discover and investigate all opportunities for the development of DG systems and how these could be financed and articulated with the local distribution network.
- Find ways of facilitating and improving communication between stakeholders, including university researchers, students, employees of the municipalities and others, to ensure that useful research is conducted, used and shared appropriately.

I therefore ultimately suggest that greater communication between policy makers and all stakeholders involved in potential strategies for the uptake of DG (in general) and SSEG PV systems in particular is required to determine the true needs for which these systems are used to meet. This study showed that a need for greater

communication between stakeholders was required to develop collective understandings of the problems before needs can be identified, and this is perhaps a useful point to consider because it offers policy and decision makers and researchers a starting point. The research recommendations provided above are therefore all starting points and I suggest them, not because I believe they hold the “key” to unlocking the puzzle to successful DG uptake, but rather as opportunities for the emergence of holistic and context specific strategies designed to ethically promote DG and SSEG PV uptake and market development wherever possible.

3. Recommendations for the Sustainability Institute and Stellenbosch University

I have made recommendations for future researchers to conduct research that both the researcher and the municipality or policy and decision makers could benefit from. I emphasise, however, that this process of conducting such research not be undertaken lightly. I admit that I did so without understanding the full implications of my decision. This is because, while I was often well received, as a researcher, by other researchers and the policy and decision makers with whom I worked as while conducting this study, this was not always the case.

I therefore strongly suggest that the practice of including researchers (particularly university students) in active research for the potential benefit of municipal planning processes be formalised. This is because, while I have stated that municipalities, such as the Stellenbosch Municipality, could benefit from much future research, I also recognise that research is expensive and may not be included in municipality budgets or mandates. This is where a formalised collaboration between local government, universities and other organisations such as GreenCape and the Energy Game Changer could be game changing.

An agreement is required (with the accompanying procedures and support structures) between actors such as the students involved, the Sustainability Institute,

Stellenbosch University and the Stellenbosch Municipality to guide the practice of encouraging students to conduct active research as part of masters or PhD level research for the potential benefit of municipalities, especially in cases where funding is involved. This will serve to clarify each player's roles and responsibility regarding the degree of engagement and supervision required, because my experience of this processes was very confusing. I suggest this agreement exist in order to protect the rights of both students and municipalities, and to ensure neither are unfairly used or imposed upon.

This is because, in my experience, this type of research, which requires this level of interaction, takes much longer than expected and inevitably gets embroiled in the local politics between institutions, researchers and decision makers. I understand the promotion of sustainable development in the face of the 'status quo' to also, inevitably, be a difficult, uncomfortable and challenging process, but I also strongly believe that greater assistance and support should be made available to students who experience such challenges and this level of tension. A lack of guidance and advice on how to manage such situations can be crushing and, in my experience, very depressing and draining, and it need not be this way.

b. Conclusion

This study began by explaining the political economy of electricity in South Africa, highlighting the point that development in the electricity sector is essential to undoing some of the socio-economic inequalities in South Africa. This explanation also indicated the importance of reducing South Africa's GHG emissions from a global sustainability perspective and that the national government has made commitments to doing so by developing national level policies and guidelines to increasing the amount of renewable energy in the national electricity mix.

Further, I have explained that the debates about mechanisms to facilitate transformation in the South African electricity sector (from the current, unsustainable situation to a more just and sustainable one) involve three key sets of voices. These include the national government (through policy), businesses (international and national, and both in the RE and conventional electricity sectors), and the NGOs (national and international). Each group has various, disjointed agendas and beliefs about what this transition might look like. But throughout all these debates, policy guidance for what role municipalities should play in achieving these aims remains limited. In the absence of such guidance, some municipalities engaged with the idea of enabling a FiT scheme to allow wealthy homeowners to feed excess electricity generated by their rooftop PV systems back to the municipal network in exchange for monetary compensation.

South African municipalities are, however, also caught between having to use their budgets to fulfil their mandates and having to meet calls to enable embedded generation with inflexible financial models. This investigation focused on a case study in Stellenbosch, where the Stellenbosch Municipality has engaged with GreenCape and the CCT Municipality in order to develop and enable a FiT scheme to allow homeowners to connect their rooftop PV systems to the municipal network.

This study has interrogated the effectiveness of the feed in tariff (FiT) scheme proposed by this local government by using a case study in Stellenbosch, that included a two-part survey and a focus group discussion conducted with ten participants (homeowners from Stellenbosch), to reveal their opinions on investing in these systems with the FiT scheme. Also included is information from transcripts of interviews conducted with three relevant policy and decision makers, manager of the Western Cape Government's Energy Game Changer project, The CCT Head of Renewable Energy, and the Head of Electricity at the Stellenbosch Municipality.

The results indicate that the FiT scheme has not been well received and SSEG PV uptake remains limited. Some reasons for this are mentioned below.

The first of these reasons is the issue that a coherent, collective understanding of the ‘problems’ and challenges to the various actors in the electricity system in the case study context does not exist. Each set of actors is concerned about issues relevant to them and is fairly insensitive to the issues and needs of other actors, and this has resulted in clashes of perspective between the municipality and participants, and between the Stellenbosch and CCT municipalities and the provincial government. These clashes damage the relationships between each set of actors and are not conducive for the development of sustainable energy solutions at municipal level because, as shown in this study, many participants expressed frustration towards the municipalities and threatened to simply withdraw their financial support and go off the grid.

The second reason could be attributed to the clash of perspectives and objectives amongst the provincial government, municipal government and homeowners regarding what the FiT scheme was designed to achieve. While the provincial level decision maker indicated that SSEG PV with the FiT scheme was perceived as a means of promoting the development of the green economy in the province, the municipal level government representatives interviewed perceived the scheme as a way of regulating (but not encouraging) the uptake of SSEG PV systems amongst homeowners. Homeowners indicated hopes that the scheme would make investing in these systems more viable and lucrative for them, in addition to giving them a way of contributing to the sustainable development of the electricity system in their hometown and in South Africa in general. While each set of stakeholders remains committed to the idea of SSEG PV (despite any concrete plans to indicate commitment to clear goals for how the benefits of SSEG PV are to be harnessed and monitored, or for how these benefits could contribute to the overall development of a more sustainable and greener electricity system for South Africa), this clash of objective has led to miscommunication, mistrust and frustration expressed by participants towards their government and towards Eskom. These feelings hamper

any willingness amongst research participants to participate and cooperate with the municipality, and will potentially deter them from engaging with the FiT scheme.

A third reason for their unwillingness to participate with the FiT scheme is that they felt “penalised” by the R140 grid connection fee. They are all right with the proposed FiT amount of the Eskom rate less 10% and would be happy without having to pay the fixed monthly fee. They believe that the R140 would extend, rather than shorten, their pay back periods.

Finally, the focus group findings indicate that the FiT scheme is not accessible to the majority of the Stellenbosch population for socio-economic reasons, and these potentially correlate with race as well. The findings also indicate that women’s involvement in SSEG PV, or the FiT scheme, appears to be limited as only one woman elected to participate in the focus group discussion. The implications of this are two-fold. On the one hand, it suggests that much work and research needs to be done to facilitate the participation of a more dynamic and diverse group of people in discussions regarding renewable energy and sustainable development in the town; and, on the other hand, that the FiT scheme is very limited in terms of the extent to which it can facilitate such interaction or participation. When triangulated and assessed from the perspective of sustainable development and complexity theory combined with the ideas offered by the political-economy perspective (that emphasises the promotion of social equality through sustainable energy development), the FiT scheme is further limited in the extent to which it can facilitate and contribute to achieving sustainable development goals laid out by the UNEP and national policy in South Africa.

I have therefore recommended that the Stellenbosch Municipality reconsider their R140 fixed monthly grid connection fee if they are committed to discussions regarding the sustainable uptake of distributed generation (DG) or small-scale embedded generation (SSEG). Second, a more long-term perspective is required to consider how the benefits of increasing the uptake of these systems can be

monitored and realised in real terms. Finally, it is recommended that future researchers continue to broaden the input from electricity consumers (and potential prosumers) and take on the task of generating knowledge on consumer need and opinion regarding the increased uptake of RE and SSEG, and of increasing the scope of such research to various race, gender and socio-economic groups to improve the promotion of equality in energy and electricity developments in Stellenbosch.

This study also aimed to compare the case study conducted amongst homeowners and decision makers in the Stellenbosch context to case studies where SSEG PV as well as other types of DG systems have been implemented, in an effort to further explore the concept of and challenges towards the uptake of DG in other countries.

I find that many of the challenges that emerged from the review of international case studies are fundamentally similar to the challenges raised in the Stellenbosch case study, and I have discussed these similarities and their implications in chapter 5 from a lens of complexity theory and sustainable development. From this triangulation of findings, I conclude that, while the South African example of attempts to increase the uptake of small-scale RE systems is not necessarily any better or worse off than many of the other attempts explored worldwide, there is great need and opportunity for improvement. My primary suggestion for how to improve is to include the voices of people on the ground (and their needs) in attempts to design workable, sustainable and green DG and SSEG PV solutions and in order to ensure that these solutions contribute to the achievement of UNEP's Sustainable Development Goals. Case studies from Peru, Costa Rica, Kenya and China, where communities' and buildings' needs are considered, have been shown to enjoy more success in the sustainable uptake of DG and SSEG PV systems as compared to countries such as Italy and the UK, who focused primarily on the financial incentives to facilitate sustainable market growth for SSEG PV systems.

I have therefore emphasised that a more holistic approach be taken towards the promotion and uptake of DG and SSEG systems in South Africa, particularly in Stellenbosch, where the SDF provides an outline for more sustainable development of the town and its electricity system. I have provided a framework from Odarno et al (2015) that policy makers could refer to, should they be interested in investigating what such an approach may look like, and have directed attention towards future research opportunities to increase the scope of knowledge used to inform decisions for the design and implementation of more ethical and just sustainable development strategies in future.

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Appendices

Appendix A: Transcript of Focus Group Discussion

Transcription of Focus Group Discussion

Date: 21 June 2016

Time: 17:00-19:00

Facilitator: Pro. Alan Brent

Co-facilitator/ researcher: Karin Kritzinger

Anonymous participants: 1-10 numbered in an anti-clockwise direction beginning with participant #1 seated to the right of the facilitator

Observer/ Researcher: Geeta Morar

Venue: Conference room, 4th floor, CRSES, Stellenbosch University.

The focus group programme:

1. Introductions
2. Individually complete survey 1 (both parts) and sign ethics form
3. Presentation- background, PV, policy change, tariff
4. Discussion
5. Individually complete survey 2

[Beginning of recorded material]

Facilitator: Just to give you a bit of a context before I get a little bit deeper into the research centre ...there are.... There's a couple of initiatives...er... that's involved... you have the researcher... activity here that looks at ...er... policy and policy interventions and this forms part of that...uhhh.... Apart from me being associated with this centre, I am the associated rector for for

for...the centre and apart from that there is also a Mayor Rector Forum...uhh... which supposedly provides academics as a resource to the Municipality to deal with some of its...woes... uhhh... and there is specifically a energy focus there and what we'll been discussing today is also us providing the municipality some inputuhhh... obviously they have released these documents and policies now for comment but I don't think they arranged any initiatives where they actively get... uh... feedback from the people [someone coughs]...of Stellenbosch. There is also a reason why we contacted the SRA...uhhhh....The SRA and that, that part of Stellenbosch in a pre...in another study of ours was identified as a potential large contributor to this policy...to this initiative of..uh..of the municipality. And in another research we've identified what the potential contribution could be from the different suburbs of Stellenbosch [bang as the door opens and closes and co-facilitator, Karin Kritzinger enters the room and takes a seat]... The municipality.... I mean, just to give you a very very brief background and context.. er... of this... They are... are... obviously surprised now that they have passed it and there are many reasons for it , we can discuss it...but the municipalities have been quite reluctant...uh.. to allow this kind of embedded generation . If you look at the Municipal revenue of the municipality, about 33% of the revenue is derived from electricity sales, so.... This is quite a step forward for the municipality to to to... go down... this route. Alright let me just say.... Say something about... the process this afternoon. I'm hoping that everyone is comfortable that we are recording this session, so that we can later reflect on it...Right... uhhh.... Then I just want to introduce some other people here... Karin Kritzinger over there... She's a resident of the SRA as well, but she's also researcher here at the centre and does work on these financing and policy issues... and Geeta Morar... sitting at the back

there... she's one of our students focussing here... on this aspect...

[Begins slideshow presentation]

I don't know how familiar you are with this centre... its been around since 200...uh... and 6; uhhh it was the initiative of the national Department of Science and Technology and we're funded through the National Research Foundation. We also ...uh.. what Eskom has realised is that they're going to have some capacity problems in terms of human resources...uhh... moving forward, so they have established what they call specialisation centres and we're also the Eskom speci...uhh.. specialisation centre in terms of renewable energy technology as part of the Eskom Power Plant Engineering Institute. Uhhh... This building that we're sitting in is uh also a recent addition to to the university, partly made possible by input from SASOL because SASOL at one stage was also looking at alternative energy as a new business... since then they've pulled out...

So specifically we are looking at solar thermal energy research group which is sitting next door and that's dealing with concentrated solar power, which is not really what we are going to be discussing today. That's more utility scale stuff.

[Changes slide]

From the Government's perspective we're seen as... well what they refer to us as a "hub and spoke bar" so its not a Stellenbosch "centre" thing uh... although the centre is called the centre, the issues and the focus area is quite wide and after the discussion today, you are welcome to discuss some other interests of yours...

but the point is there are many institutions in the country that are involved in some form of renewables... and example in solar PV... we have the Scartech chair in Solar PV but Nelson Mandela bay metropolitan also features quite strongly there... uhhh... wind is between ourselves and engineering and UCT, uh, at this point we don't have the wave and ocean energy... Biomass: we have the chair in biofuels and cleaner fuels, and then Policy; our colleagues at UCT or the CSIR are also in the uh... space. So its not that we try to do everything ok, but the government sees us as a... facilitator... in the lar, larger network.

[Changes slide]

TIME STAMP: 00:05:04

Right so for our study... and I this, Ah alright I'll get to that in a moment... but for our study we really want to understand what the residential sector feels about embedded generation uhhh, and really... is it going to take off? Because it's a question that we've had with Drakenstein as an example they've had a tariff structure similar to what you see to-today uhh in place for more than a year and we really haven't seen that much PV take off there so we were thinking that maybe an issue is that people don't necessarily... [enter late participant, Participant 10] understand these systems and there is still a lot of uncertainty and lack of clarity around it and I think that's what today is also about... why you as residents... ja... and sharing some knowledge in the area but saying that, we have all people from [gestures at Participant 2] Energy Partners and a couple of people that have put up systems on their homes... [vaguely gestures at Participants 1, 2 and 3]... so everyone has a different level of understanding so just bear with me as we go through this

discussion [gestures at the slideshow presentation] and the slides.

[Changes slide]

TIME STAMP: 00:06:10

Alright so... Our aim is that we want to inform about the policy change that has been put out by... by the municipality, discuss some of the tariffs, discuss some of the other technical issues; we've put some stuff up on the slide... but really its an open discussion- you can interrupt me at any time and we can discuss any issues that are of interest to you. Uhh...ja... so we want to gain some insight into what your thoughts are around embedded generation [someone clears throat] and if not this then what do you prefer instead...? What are our alternatives?

[Changes slide]

TIME STAMP: 00:06:47

Right so, who wants to know? Obviously this is a research activity, uhhh, its part of the mandate of the centre that we develop new knowledge and that we inform policy makers and so the Stellenbosch Municipality wants to see the outcome if this uh in terms of feedback on their policy... Uh... we've had some engagement with the South African Local Government Association, so wider than single municipalities – its becoming a national issue and as I said it has to do with the revenue streams of the municipality and it's the business model of the municipalities that's being discussed at this time... actually as you all probably know, the western government has this whole green initiative so they

are... and there is an entity known as Green Cape behind all of this and they are trying to assist the municipalities in terms of implementing these kinds of policies but yes... don't worry- we're not going to divulge your names...[mumbles something: unintelligible]. (can check on audio device 2 if this was recorded there)

[Changes slide]

TIME STAMP: 00:07:49

Alright! PV in general...I mean...do we all understand what PV is and how it works? [looks around the table....] do I need to show a short clip[silence...] You all understand the photovoltaic effect? You understand the difference between the PV system and solar water heater?[silence]....[all participants nod] ... Ok [nods head] Everybody...? [looks behind him...] ...yup...? Ok then I'm not going to go into that and play the video. So today we're not still talking about solar water heaters... we're talking about direct electricity generation solutions.

[Changes slide]

TIME STAMP: 00:08:21

Ok so this is... and there is a hard copy of the policy in the middle of the table there... uhhhh... we'll circulate electronic copies er, after, er, this discussion today, we'll circulate it tomorrow. In essence the document that has been drawn up has been released. Our first draft of this policy was done about two years ago so its taken two years to get through council and to get to this point and

the purpose is to regulate the new trend where electricity consumers can become generators as well... what's the term they use...Karin...? "Prosumers?" [Karin nods]. Ok so now we're not only consumers anymore- we potentially become prosumers. Right... then what do we mean by "embedded generation?" There are basically three different circumstances: so, you can either generate electricity for your own consumption, uh... and you're not connected to the grid... ok that's not going to be an issue for us... but certainly for some people in the municipality who can go off grid – there is that option. Uh.. then there is generation for your own consumption and you are connected to the grid but you don't feed into the grid... so for example I have such a system where I don't feed back into the grid but I have battery storage and I use the grid to supplement my use... and then.. and this is an exciting point for us and is seen as a tipping point for renewable energy... (you all know about the renewable energy big bill programme that's happening around the country... so at utility scale it's sorted out but we're still struggling in this country for small scale compared to other countries like Germany, some places in the states and so on... where indeed you can be connected to the grid and you feed back surplus electricity into the grid and the municipality or the utility pays you.)

Um... just, just so you know it's not something that is entirely new in South Africa... there are some people who have been generating and selling back to the grid but at this point in time there is no standard policy framework that governs all of that. It's usually a one on one situation between an entity and the Municipality or Eskom. Usually it's between another entity and Eskom- as far as I know. Right so it's that third one that we're really interested in from our side.

[Changes slide]

TIME STAMP: 00:11:00

Right so what it does... the document... is it introduces some terminology so we all understand what we mean about PV systems etc . uh, ja it lays out the technical guidelines that your systems should comply with and we're still in the process... in South Africa... of finalising the technical standards through interviews so that's going to be an issue but we more or less know where, where that is going... so the municipality is basically piggy backing on these draft things that we're sending in terms of what kind of technical systems we will allow... so I mean we have experts around the room but your system must realise that for example the municipal grid has gone off... and not feed into the grid at that time... so its simple things like that. All right, it also explains the application process... ok so uh, why do they want people to formally apply? Ok, Well obviously first of all they are mandated by government to report on who's generating electricity in their municipality but it is not quite clear to me at this stage yet and from the document and that is... do they really want to report on everybody who is generating including those generating for self consumption and not feeding back into the grid- because people are doing that and its not really recorded anywhere... and that's a big gap in south Africa - is that we have some feed back on that's happening in the market- and the market has really taken off, uhh... in the last two years but its still the data is lacking. There's also other reasons for their application in the sense that they need to understand how they're going to manage their reticulation system to the grid so substations and transformers and so on can only allow a

maximum amount of feed in back into the grid before we need to do a grid study so we need to see who's planning or who is proposing to generate electricity so there is an upper technical limit to what can be taken by the substations- typically 15% or so of capacity... Right then it goes into how things can be measured- obviously you need a bidirectional meter that could potentially measure how much feed back is going into the grid, how their billing is going to work uh, etc. Any questions on the content of the policy?

TIME STAMP: 00:13:16

Participant 6: Where can we get that policy? Do you have copies of that available?

Facilitator: Yup, so what we'll do is we've already got your email addresses so we'll circulate it but it's also on the municipality's website but like I say, you decide for yourselves, but they haven't been very forthcoming in terms of asking for comments from the residents.

Participant 6: Ja, I wouldn't know where to find it on their website ... I don't look at their website very often.

Facilitator: Ja we only know about it because we're working on it. Ok so um, the last year, in May last year, uh, NERSA (the national energy regulator) was supposed to release a document. It was a draft that would standardise all of this but it has not been released yet. Ok but the municipalities have seen the increasing demand in the market so in some sense the municipalities have been moving forward with this process ahead of NERSA ... so now they are in the process of applying to NERSA mainly for the policy to be allowed but also for the tariff structure that we will be discussing so they are in the

process at this time to apply for new tariffs.

Participant 3: Are we going to discuss mainly how this affects us in Stellenbosch? And what their policies are going to be in Stellenbosch because I've heard of various means of them and various levels of how its been applied already so for example in Cape Town you can make so much and can feed back and then you can reverse the tariff and then some of these guys are ending up with like a R7 bill for a million rand mansion...

Facilitator: Ja... but Karin, do you want to give some feedback on that because that's already been... the tariff structure has been out in Cape Town for more than a year, you know but actually they haven't allowed that much...

Co-facilitator: It depends, I mean I could have a two hour discussion on tariffs lets walk through the day and we can think about it later but from the 1st July Stellenbosch Municipality will also have a feed in tariff so you will also be able to feed into the grid and you will also be compensated for it... um... ja... at the City of Cape Town you could um, there are different options of tariffs.

Participant 4: Ok, just a quick question on the application process: does it mean each of us has to apply as a generator [Facilitator: yes.] So there can't be just an installation company that can register as a generator and then where they install then its fine? Is that acceptable?

Facilitator: No, the way I understand the application process is that it's per tariff, ja, and that goes back to what I said earlier. If you look at previous studies that we've done: we have mapped out the entire grid system of Stellenbosch, we've looked at the transformers-

where they are- and what can be allowed. This is a big issue, for instance uhhh, I mean in our case the primary school is investigating some options but if the school should go big, following on this they will take a lot of the capacity over that specific area ... Ok. Alright lets look at the tariffs. This is the tariffs [on the slide] and there are also hard copies there [on the table in the room] uh, you'll see there is a whole range of tables. I've just highlighted what I think is most important to this discussion today, alright, and that's just basically what they call DOM 3 and DOM 4 domestic. Uh, DOM 3 is domestics that use more than 500 kWh per month um, and they are using prepaid meters, OK? Uh, DOM 4 similar, but they are credit meters, so the old billing system where you get billed per month. And there you can see, and this is an important aspect that we're struggling with in South African policy space is that we buy electricity in a step policy structure so uh, there is a fixture for the month and there you can see if you're less than 350 per month that's what you're going to pay (80c) and if you're somewhere between 300 and 600 kWh per month then its about 150c per kWh and it can jump up to 180c. Ok, uh, having said that, last year, one morning and the meter had run empty and I was definitely sitting way over 600 kWh and I quickly went and bought some credits over the internet and it turned out to be R2.50... so I don't know exactly how that works but that's a big issue so first know that. And that becomes important when we discussing size of systems etc.

Participant 10: Sorry, those rates that you're showing there, is that what a household is paying to buy electricity?

Facilitator: Yes.

Participant 10: But the heading says “feed in tariff.”

Facilitator: No that’s just the slide.

Participant 10: Oh, so that’s not the feed in tariff?

Facilitator: No, it’s the “feed out.” Ja so this is what you’re paying... well what they are proposing that you pay in the next financial year.

Participant 10: Ok so this has nothing to do with feeding back into the grid?

Facilitator: No, not yet, the next slide is going to get into that.

Participant 10: Oh ok. Great. Alright.

Facilitator: Um, just to highlight some of the municipality’s challenges is that they pay Eskom a time of use tariff, ok, and depending on seasons, days, etc. they can pay Eskom more than R2 per kWh, so it means that they selling electricity at a loss, but they pay Eskom a very low tariff during the day and then they selling the electricity to you at that rate (indicates slide) so that’s how their financial model works. Now you can also understand their position because I mean your PV systems are going to be generating electricity exactly at that time of day when the municipality would actually want to sell that electricity. These are some of the issues. Um, alright so this is now for around uh, self generation and the actual buy tariffs are very similar but I want to highlight here uh, so this is the fixed linking cost per month: R140 and then they will reimburse you for the energy at the Eskom tariff minus 10% so I think if I’m right it would work out to about 60c at the current tariff so it’s probably going to go up to 70c- they going to buy electricity from you at

about 63c an hour...

Participant 10: Not time related or...?

Facilitator: No

Participant 10: Just flat?

Facilitator: Yes. Its flat, alright and um, the reason for that, I don't actually understand why -10% to be quite honest but NERSA said the municipality can't pay more than they would pay Eskom...

Co-facilitator: Its in the Electricity Pricing Policy, its actually law that no municipality is allowed to purchase electricity at a higher rate than what it can be purchased for from or otherwise...it's an old law that came out from, you know, sort of municipalities purchasing it at whatever um, rate.

Facilitator: Well I don't know how that Cape Town gets around that...

Co-facilitator: Ja they also just get it at Eskom rates. The City of Cape Town had a pilot project with three users, where they paid them, it was just a one on one where whatever you paid you got back as well, so it was a net metering system, which Drakenstein has at the moment as well and I think George also uses that net metering. So what happens is that they apply to NERSA for the tariff, the Feed in Tariff, NERSA is not allowed... they can't allow it because it's against the law, so they reject that application, so what you do is you call it a "pilot" tariff because they not expecting many people to be on it in the first year so I mean even if... if 100 people go on it, it will be a lot but it will be small in comparison to the

municipality, that's why they could call it a pilot because then NERSA doesn't have any problems around it...

Participant 10: 60c a kWh is not commercially viable.

Facilitator: [Sighs] Well if I look at my own system at home I can't sell anything so anything I don't store in batteries is lost, in essence, and also lost opportunity.

Co-facilitator: Ja, and also 60c is not that much less than 89c which is what you pay for your first 50 kWh anyway so...

Facilitator: And the other thing is, and we'll get to the cost in a moment and pay back and so on, but we can expect that- well we know what Eskom is going to be asking and for the next couple of years and the municipalities are going to piggy back on that so we can see that that'll go up [indicates the feed in tariff which is Eskom tariff less 10%] so then you'll probably get more for your Rand.

Participant 1: (only woman): So how are they going to register how much you have put back into the system? Is it going to be a separate meter? Because in the States we- it was all tied into the same electric meter that was read by the electric company and it just spun backwards if you were putting electricity into the system so...

Facilitator: Ja, no they don't want that and what we do know already in our neighbourhood is that people are already selling electricity to the grid like that uh, because you can exactly do that, if you have a credit (an old disk meter) and you generate it's just going to spin back which effectively means that you're selling electricity at the same rate that you buy.

Participant 1: Exactly!

Facilitator: Um, ok so there is a national policy to move away from those kinds of measuring systems uh, Tshwane and some of the others have been effective with that so we can expect that its going to happen in Stellenbosch as well to combat that situation so technically there are two ways: there is a meter that measures what comes into your household and then there is a separate meter that measures what goes out (I don't know, it's something like that) or you have one meter that does both. Uh, the way I understand the policy, they are opting for the bidirectional, similar to what City of Cape Town are doing but, ja, so, if you're on the credit system, they are going to come once a month, they are going to read what you use and then reimburse you for what you actually supplied- there are actually TWO different readings.

Participant 10: But the net-metering is illegal as far as I know, at the moment.

Facilitator: Ja, its illegal

Participant 10: Ja but guys are doing it, if you lucky enough to have one of those old disk...

Participant 8: But they can very quickly take the old type out and put the new one in and then you've lost your investment...

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Facilitator: Ja, that's a risk involved... I mean some of the guys in the neighbourhood that did this about 2 or 3 years ago- its fine. Ok, But

we can expect that technically that will address that tariff. Right so the R140 per month is also a contentious issue for your financial models, but before this it worked out to what? R10 a day I mean then it just plays havoc- I mean to pay R300 before you can actually can sell excess supply. So this is slightly more positive and obviously they've learned from Cape Town experience but this is what they're suggesting at the moment.

Participant 1: But then...

Participant 10: But the joke is with that.... Sorry (interrupts participant 1: the woman)...

Participant 1: No, go ahead..

Participant 10: Is that that meter that you will be working with most probably doesn't require reading, it just logs onto a computer...

Facilitator: Yes well probably a smart meter

Participant 10: Same as above: There's actually no reading taking place...

Facilitator: No... ok now lets...

Participant 1: (Woman): Admin costs but if you take into consideration... sorry just my thought process, if you take into consideration that you've got to pay this R140 a month or it could be more, um, and then you only get say 63c back, um, if you're using the 500 kWh a month or more, so its costing you R2 something, um, and you want to try and keep that um, keep your costs down to try and get into the lower tariff, you're already paying out R140 a month before you even see

any return on what you're already putting into the grid and then you're only getting the lowest kWh usage amount back... so its...

Facilitator: Well the way it would work... ja... I mean the way I see it, it goes back to the step function, I mean if you can first of all, if you can keep you kWh to be low down, the highest step tariff...

Participant 1: And what is generally a average usage? Is it 500 for a single residential household a month?

Facilitator: That's an interesting question where people don't know... I mean, even myself, until recently-

Co-facilitator: There is nothing as a average... it depends so much. It depends whether you have a gas stove, whether you have an electric heaters, whether you have a solar water heater, depends whether you have children, whether you have under floor heating, or it depends on so many things but you must also remember that that 83c of everything below 50 kWh is a subsidised rate, you know I mean they can't provide, the municipality can't provide you at 83c so you can't say 83c is sort of the norm. It costs them much more, that's why um, they have an inclining block tariff so is not like 83c is what is the norm...

Participant 10: The hope is that if you do install a solar PV system you'll move yourself into a lower demand bracket [referring to Municipality's step tariff system]

Participant 8: But they don't want the 83c clients in theory.

Facilitator: No they don't really.

Co-facilitator: They're the municipality! They HAVE TO take the 83c clients, you know, I mean that is what the Municipality IS. It's a service, you know, so they need to make their books balance. That's basically what it is. Just the same way you want to install a solar PV system and you want to make your books balance and you want to not lose money out of it etc. the municipality also provides to everybody and those people who are only on 50 kWh... well the first 50 kWh would be for free, but then they pay 83c, you know those people won't be the people who can afford to put PV systems on. They are the poorest of the poor.

Participant 10: Ja, I use about 50 kWh a day.

Co-facilitator: 50?! Ok, you see there you go... you're not paying 83c, you're paying R1.78

Participant 8: Ja... he's got PV.

[Laughter]

Co-facilitator: And if you were in Cape Town you would've paid R2.20 a kWh...

Participant 1: Right, it's what you said... you may not be putting in anything at all if you do that.

Participant 9: I mean it's relative right? So, if you don't have a solar system, you're going to pay R140 a month anyway so, I'm almost seeing that as a zero impact so whether-you have a solar system or not- you're going to pay a fixed charge per month

Participant 1: ...but your still going to pay that! You're going to pay an additional R140!

Facilitator: Ja, so you're going to pay R280 now.

Participant 1: Yeah

Participant 10: I think the thing is, if you install a system, and you're not planning to put back into the grid, you need to size it in such a way that you have minimal excess energy, especially if you don't have batteries. So this discussion speaks to: should I be investing into additional panels to sell power back into the grid?

Participant 1: hmmm, yeah, and is it worth it...

Participant 10: Ja and even on utility scale, panels, no storage comes out now at 60c per kWh so what its saying to me is if you're getting 60c... that's break even ... at utility scale, most probably you making a loss here.

Facilitator: Ja. Ok we'll get to sizes, because I mean we need to discuss that little one because that is important- what you're saying. Even with myself, I've sized the batteries to keep me going through load shedding but still in the summer, I could be producing more- so I could be selling...

Participant 10: Ja you see, I think the thing is a lot of us are in a position to invest in these systems for convenience, not to be shed, load shed. It's not really to be a commercial exercise...

Facilitator: Ja, we'll get to that in a moment...

Participant 10: ... not to be a commercial exercise....

Facilitator: Ja, ja, we want to get a sense of why you'd prioritise this or not... alright. Lets get into... we can come back to the tariffs if you want, later but lets get a little bit onto the cost because that's what we have been discussing: you know, it all depends on the size, uh, which company you purchase it from... you know there is quite a range of costs out there um, we have put some figures down here... [indicates slide]... we've seen lower figures, I mean especially if you go to quite a large size... but typically uh... 1-2 kW system, grid tied, no batteries, you're looking at R30 a Watt, might be R20-R25 a watt for some systems uh, 3 kW, also no batteries you're looking at about R50 a watt... uh... so that's sort of the range that we're looking at. Um... with batteries, you know it jumps up significantly. I think this is one... if you have batteries then your system, <sigh>, essentially its broken down into parts of 3: there is the panels, the inverter, and the batteries, that's more or less what it boils down to

Participant 10: And the electrical work

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Facilitator: Ja and some electrical work to get going so that's more or less what the cost breakdown is and that's the other thing we need to understand around these systems, and I think we get into that here, um, ja and the question is: how many appliances can you run on each of these kind of systems and we're going to talk about the practicalities and get into some examples in a moment, but the point I wanted to make here is around calculating to define your finances around this: yes the PV panels themselves will last around 20 years,

the inverter is going to last you 10 years, ok? You're typically going to need to replace that, and the batteries: if you really look after them very well, deep cycle normal deep cycle or lead acid batteries, will last you up to 5 years. So those are significant costs associated with it. Do you want to talk a little bit about the technical side and the cost of these systems...

Participant 10: Ja that gels with the costs at my place...

Participant 6: I just want to understand that 7-8 years pay back, (points to slide) is that assuming the ability to sell back into the grid or is that just for your on use?

Facilitator: Yes, that's what we've seen for our own use..

Participant 6: Oh so if you could sell back ...

Facilitator: It should be looking better now...

Participant 6: Assuming I can generate more than you use...

Facilitator: Ja

Participant 10: Ja, you can spend more also...

[Pause]

Participant 10 : But your inverter costs most probably stays the same, its just additional panels...

Facilitator: Ja that's a very important one because I started off in November with a 2 kW system with a 3 KVA um, inverter, right? Then I quickly saw: right this is not going to make sense because I had to bypass the swimming pool, etc. so what happens to these guys when they arrive at your house is they're going to split up your Dv board, ok? So, in

our case for example, we have a borehole, and we have a gas top stove and electric oven, so they bypass that- you don't want to be running that off your system, uh, so basically there is one small loop in your house where the plugs and so on are purely on the solar power. The stove is bypassed and the solar water heater as well, and initially with the 3KVA I had the pump bypassed as well. The problem is anything else on a DV distribution board that's coming through the inverter- whether the power is from the municipality or from the solar panels doesn't matter- if the inverter is 3KVA capacity then that's all- alright, so you can't go more than the 3KVA and that's very important. I saw the limit in my household to that 3KVA and from a cost perspective it didn't make sense, for us, if you couldn't run the pool on the solar power because the pool is running 6 hours a day, in the middle of the day, when the sun is generating electricity. Other appliances come and go in the household. So then I moved up to a 3kW system and put a pool system in there- and increased the inverter to 5KVA and now its interesting to get a sense of what your household consumes. So we have put a monitor and you buy it for R1000 and it you leave it standing there in the kitchen and its measuring the electrical power coming from the municipality into the household. So if your daughter switches on the blowdryer and somebody switches on the kettle and someone else is busy making a toasted sandwich, you very quickly get to 5KVA, so we have a technical limit. It's not a "plug and play" system we have here, you need to understand your own energy consumption and um, how you actually manage that electricity consumption. I think it's the whole story... I mean first you go for energy efficiency, managing your load profile before you simply go and put in a renewable energy system.

Participant 6: But, but, now when I... I'm just wondering, a residential scale to

scope this thing, you actually want to see that load profile before hand and you wont be able to do that per house.

Facilitator: Um, you can. With this monitor that I mentioned.

Participant 6: Ja but to a point, I mean you actually have to do that first, before you design the system...

Facilitator: Ja I mean, uh, the professional guys can come and look at your appliances and do an analysis for you, a reasonable, good exercise. Interestingly enough, as an example technically, I only found this out after we installed the system, is you can't switch in an electric lawnmower...

[Laughter all round]

Participant 1: What happened?

Facilitator: I was called out of a meeting to go home, and some of the electrical guys in the meeting said basically when you plug in a lawnmower, your system sees it as a short, which is not useful.

Participant 3: Have you got batteries on your system?

Facilitator: Yes

Participant 3: ...And it still can't get the lawnmower going?

Facilitator: It's a physics issue, that it sees it as a surge.

Participant 3: Oh, so a pool pump it can manage but not a 2kW lawnmower?

Facilitator: Inductive motors it can't handle...

Participant 3: Well a big one. A pool pump is also inductive, but its much smaller...

Facilitator: So, I mean this is something else that you've got to consider and one learns as you go along. To [Participant 10's] point now, earlier on, I mean so, why would you consider a system like this? I want to get your views... I mean you're all here, so you're interested.

[Changes slide]

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...We've put down some ideas up there, load shedding is one issue...

Participant 6: For me, its saving money.

[Murmurs of agreement around the table]

Facilitator: Saving money...

Participant 4: I think for me, its number two. [indicates slide] Ja, it's the having the control. The load shedding is not so much the issue; you can plan your major usage outside those times, as long as they keep communicating. You can plan your usage and just provide lighting in the night and you can do that with small batteries- the new ones.

Facilitator: We are busy with a new study for our faculty with diesel generators and so on. The other issue is when we had load shedding a lot of people went off and bought diesel gen-sets right, now they are standing idle there now for the last year, and you're supposed to start a diesel gen-set every month and so on otherwise- it goes haywire. So it's a lot cheaper obviously, but it's a sunken cost into something that you don't get continual benefit from...

Participant 8: What's the cost of generating electricity through a generator?

Facilitator: Uh, about R3, 60 per kWh.

Participant 10: Even more I guess

Facilitator: Ja, well it depends on the diesel price.

Participant 8: And an unhappy neighbour

[All laugh and nod in agreement]

Facilitator: Ok, now...

Participant 10: Everybody has a different um, view, motivator rather. The few times

I arrived at home from work, at night, with my family in a *tizz*, looking at me, I realised: I am prepared to pay a hell of a lot of money to have the lights on when I get home!

Participant 1: Yeah, its more of an irritation, I mean it's not a train smash, it's just

an...irritation. It interrupts your free will!

Participant 10: An inconvenience...

Participant 2: I would say the um, apart from the possibility of paying less, I hope it is a more ecologically friendly way of life that can be sustained by this and maybe that's an argument that we need to discuss. I mean if I could help Eskom not to burn all the coal and put all the smoke up there...

Participant 1: Or put Nuclear Plants online...

Participant 2: I have an, an ethical view on it... it would be good to hear from you if you think that's uh, sustainable?

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Facilitator: Ja well I mean you're asking the converted here, I mean its uh, in my mind at least that's uh, this is me thinking that I am doing something good. I mean I have batteries- at this point my house is probably running on the batteries so- because you can set the inverter to keep the battery store until it is absolutely necessary for load shedding or does it use the batteries you know, in the evening. So at least I feel... 6 p.m. at night... this is peak period for Eskom alright and they're running the open cycle gas turbines at peak capacity on diesel full blast at this point just to keep the lights on. That's bad from the green perspective and bad from the cost perspective so the Eskom figures internally say R 3.60 at this point in time of the day, um, we've estimated more than R4 per kWh from an actual economics perspective... so the C.S.I.R. report already indicated that the renewable energy build programme saved the country R70 million

already just in terms of diesel saved and other economic issues. Right but er, now like I said earlier on, one would start with energy efficiency measures, load shifting, before one looks at...

Participant 10: I think heat pumps are the first thing you should put in before you consider all these things. Get the heat pumps first.

Facilitator: Ja the figures have been thrown around, my co-facilitator will also give you a hour lecture on that because in theory a third of your electricity consumption goes into heating water um, but we've seen cases now where that doesn't necessarily mean people reduce electricity consumption. We've had some strange cases where people install a solar water heater and then they say, "Great so now I can switch on my under floor heating..."

[Some participants laugh]

...So that's the nature of people. Um, but ja, I mean, the energy department its something they promote a heat pump that's driven by a PV system basically uh, with a big enough tank- so during the day you're generating and it can carry you through the night.

Participant 9: Ja, so for me I think its almost interesting to know what you're optimising for because a lot of your bullet points speaks to storage- which is in my mind a little bit of a separate decision to: "Do I want to put solar panels on my roof?" Because, with a feed in tariff you can effectively say: "Ok well I want to use Eskom or the municipality as my battery," so you have a decision to make: why (if you want to consider a battery) why do you want to do it? Is it to safeguard your self against load shedding? Or is it to save money? Um and I think the economics of storage, whether its putting it into a

battery or whether it's, at these rates, putting it into the grid, it's not economical. There is another reason why you want to do it so it's either a lifestyle or an ethical driven decision. Um, I think where our velocity comes in is a battery is an expensive thing but a water tank that stores hot water is also a battery but it's a lot cheaper- so you really need to decide what are you solving for. Um, and then you need to design your solution specifically around those needs so I think if you have five people around the table, you have five different answers for what people are solving for. It's just interesting for me to see- it feels like there is quite a strong storage underlying component here, which, for me, is slightly separate issue from the PV decision.

Facilitator: Yup, that's important because you can simply go onto your roof and put up a whole lot of PVs and you sell as much as you can to the grid and you'd need to run your financial models and it's a lot cheaper; as I said, you don't need to replace batteries every five years but I haven't looked at...

Participant 9: But I just, sorry, maybe I'm going into too much detail, but I just did a very quick back of the envelope, you would never sell back into the grid at this scheme- for economical reasons. Um, I mean for me, if you're going to pay R140 a month, as just a surcharge fee, to use it as a battery, well the first 2 kW of system that you put on is just to pay for the right to put back so if you go and look at what you said a 2 kW system costs and effectively the municipality ask you if you are going to be willing to invest R50/60/70 000 just to have the right to put something back into the grid so you haven't... you start with R70 000 in the negative, um, so the economics of it just absolutely does not make sense so the right thing to do is just size the system for what your own needs are... and then try and adjust your lifestyle as much as possible to now use what you have and what the passive

things that you can do is at least shift things like your hot water production to like the middle of the day when the sun is shining um and run the pool pump in the middle of the day when you have the energy but to put it in the grid just absolutely doesn't make sense...

Participant 10: Not at those rates.

Participant 9: Not at those rates.

Facilitator: The one thing is that we need to... we still need to do some forecasts like I said earlier in terms of what the projected increase were going to be and then when the potential pay back is going to be, because that's ultimately the issue.

Participant 1: Yeah, because the 7-8 year payback could suddenly turn into a 4 and a half/5 year payback because of the increase in electricity tariffs...

Participant 9: Ja I think, those paybacks... one must be very careful when you look at those paybacks, I think a payback like that assumes you use all the electricity you generate for yourself – in other words, you take the R 1, 70 and you discount that over a 7 year period. The moment you start bringing into the calculation that you're going to start selling back to the grid, then effectively you're not selling at R 1, 70, you're only selling at 60c but you're starting R 140 in the negative every month, so you will never have a payback on that- it will be an endless payback... you will have to replace your equipment before you will have paid off that debt.

Participant 9: The numbers right off the bat sounded not right...

Facilitator: *Yup*, this has been the critique of the Cape Town Tariffs as well. Even more so because they had the proposed R300...

Participant 10: I just can't help thinking, you know that there is a mechanism and there are a lot of hurdles to get over that but it's more viable if a private person sells to a private person, you can then charge any rate you want- you just need to cover the cost of wheeling in between so if the municipality is prepared to mask this under people selling to each other, and I'm selling to the school and I'm selling to the... then you can set up the rates that makes sense for both parties. The school is still saving because he's not paying as much as he would have from Eskom or the Municipality and the other guy is not getting 60c, he's 80c or 90c... or whatever.

Facilitator: Ja that's interesting discussion as well is that we don't have a standardised wheeling tariff because that effectively could- the municipality could still make money, out of the wheeling tariff...

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Participant 10: Yup, exactly you just cover their wheeling cost and then so... this thing where you're subject to the national policy- what is it- the mega flex rate or something? I can't remember, it's not going to work. Not commercially, not so far as I can see.

Participant 1: You know the country has a big potential here, and if they pushed it- if the government pushed it, that um, people maybe even had better subsidies if they invested in this type of stuff, but to encourage people to invest in this, and to sell back and I think they should have the meters turning in reverse, and uh, and reap the benefit of reducing the national load on the, on Eskom, and get Eskom out of the crap

that its in, at the moment and not have to put up nuclear, new plants and stuff like that, it would save them in the long run. But government is government, and they don't want to do that! They would rather see Eskom struggle than to actually do something that is more beneficial and is more business savvy so it's always going to be an issue! You're never going to- why spend- as you say- thousands, tens of thousands- hundreds of thousands- to get nothing back? You might as well just service yourself and get the heck off the grid! And not work with government. You're green, that is a benefit, um, and you don't have to deal with the admin, the tariff hikes, all the rest of the crap from government whether its Eskom or municipal...

Participant 10: The Dilemma here is that um, the more people who get off the grid, or reduce their demand, the deeper trouble Eskom is going to have-

Participant 1: The more trouble Eskom is going to have...

Participant 10: They're losing their best payers- that's the problem- they just remaining with all the bad payers now I don't know how they are going to solve that problem...

Participant 10: They're not doing it from a business perspective and that's the problem with government...

Facilitator: Ja so Eskom is really...

Participant 3: [Interrupts] Um, if you go back to the questions of why you want to put your own system in, I believe that it varies very much from the current situation- last year everyone was scrambling to get hold of an inverter or a generator or these little plug in things... its not an issue

at the moment ... why? I've been told its because the mines have scaled down to such an extent and they're the main consumer of electricity because of all the strikes and they've got rid of all of these guys, so I think that's very... let me just ask another question: when do you think when do we think that its going to become a crisis again like it was last year? You know, I've spoken to some guys that I know and they've said the economy is just cruising at the moment and if they get the mines going to get the economy going its going to become a problem- just over night... so the human is a funny thing, when its not a problem you're not worried about it but as soon as the power starts going off everybody starts scrambling for generators, inverters and start putting up panels and everything...

Participant 10: I think the short answer to that is that if this country at any points wants to picking up its economy- we're back in problems

...

[Other participants agree]

...That's the short answer.

Participant 8: But they're building, like crazy green energy plant: the wind and...

Participant 10: Ja but it doesn't solve the whole problem.

Facilitator: Ja I mean we can go into a long discussion on Eskom's woes but the fact of the matter is um, if I talk to people within Eskom, they say that every morning they come to work they are quite surprised the lights are still on.

[Laughter]

Participant 1: Well that's reassuring!

Facilitator: I mean its quite a large number I mean a large part of its fleet- is very old- I mean some of them have been brought back from decommission...

Participant 10: They are actually very good- the engineers are excellent at keeping those plants up and running- they're very good. But its shaky- you know- YOU know also..

Participant 3: When do they expect this new um, nuclear one to come online?

Earliest is 2025 I think. I'm told by one of these retired professors that at a maximum those plants are only going to last for a year, so we will, they said even if the mines don't get going and overload the system, the old ones will conk in before the time and then you will have to put something in place -if you don't want to end up in the dark...

Participant 10: If I can just compound that: the current price path on Eskom rates, which is quite a steep curve, does not account yet for that new build. So as soon as they want to replace any of those stations, the price has to increase more than 12% per year so...it all speaks to the justification for doing your own thing. But feeding back, I think that's one of the things you wanted to hear today, my opinion is at those rates: not worth it! [Shakes head]

[Murmurs of agreement from all round]

Participant 3: Also- I'm just a bit cautious that if sufficient people start feeding back into the grid- and Eskom can't sell it to you, they're going to institute a levy per household for you to have that facility to feed back and then it's not worth your while at all. Much higher than what it is now- where they see they are loosing out, they'll say: "I'm going to tariff you higher!" Or they put your taxes up, same kind of thing and eventually it's not worth your while.

Participant 9: I think that if there is a message that needs to go back to the Municipality: I'm even happy to put the extra energy that I'm generating back into the grid for free to help the country- but don't – don't – Don't charge me a R150 to do my part for the economy- because each and every inverter you can set up that you should not export to the grid or that you can export to the grid, um, and I have less of an issue with the 60c that you want to pay me- its not cost reflective but I can live with that- but don't penalise me if I want to make my contribution- I feel like this is a penalising system- I mean the economics doesn't work for me to put it back into the grid but on top of that as well you want to penalise me by charging me R150 for the right to make a contribution- it just doesn't make sense...

[Murmurs of "hmm-hmm" and "exactly" from various participants]

Participant 10: So there's two departure points: the one is that you've got a system and sometimes you'll have excess power so the question is –do I want to pay to do that? The other one is that I mentioned earlier is that you have a system- you can make a decision: do I want to invest in more so that I can sell more power? And the answer is clearly NO for the second one.

Facilitator: Ja, because I mean the ... it goes to [participant 9's] point: If I've got a system, there are times of the day that I could pull more watts out of those PV panels and the batteries are full, I mean you're away for a weekend... *jeeslike* I mean I don't mind dumping it... if we're going use that word...

[Murmurs of agreement]

...Ok... and there is one other issue that I forgot to mention that is: those tariff structures, uh, feed in tariffs are only for DOM4 which if you recall, those are the credit meters. DOM 4 and DOM 3... so if you have a net meter in your household like we do, even if I wanted to dump- I can't. Technically through net metering you can't...

Participant 10: I think one thing you must just recognise is that we're a privileged audience: you and I and other guys who install systems here can go *gunghoe* to install a system that is nice and big and has excess power... most people actually will still draw all the time from Eskom, they are just really optimising their system to take the peaks out...

That might be a different discussion: While those guys clearly wont put in excess power... so we have excess power... but I think they're in the minority- most people wont have excess power- they'll have to invest to have excess power.

Facilitator: But still, the minority can make a, can potentially have a HUGE impact for the municipality.

Participant 10: Yes, but not in terms of feeding back.

Facilitator: No.

Participant 10: Just taking less.

Participant 1: Just getting off the grid.

Facilitator: Ja I mean last year we did an investigation with my house and other houses in our neighbourhood... some people are paying R6000 a month for electricity so just put up whatever you can and bring it down- but interestingly enough, that kind of household doesn't care that they are paying R6000 a month.

Participant 10: Well, I used to pay R6000 a month in winter. And now I'm paying just over R2000 but that's after installing the system... ja that's R4000 a month, that's not too long a pay back period.

Facilitator: And what size system to you have?

Participant 10: 3kW

Facilitator: 3kW, ok. Not with batteries or anything?

Participant 10: WITH batteries, as you said right now its running off batteries- my lights and everything

Facilitator: Ok

Participant 8: Why are you using so much electricity?

Participant 10: My wife baths a lot.

[Laughter all round]

Participant 8: Must be a lot hey.

Participant 10: Ja, I know...

[More laughter]

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Participant 8: It's about saving.

Participant 10: My family doesn't have a sense of what power costs... I just keep my fingers in the dam wall.

[More laughter]

Participant 3: I've just got a question about varying tariffs: have any of the municipalities instituted it where after midnight you have a cheaper tariff? I had that in the UK years ago where they have these storage things where you can heat your house after midnight for like a third of the price so if you headed it from 12 until 4 or 5 and then the power came on again the tariff changed then they turned off the heating. Have they instituted any of that for domestic use in this country? Any municipality?

Facilitator: Uh, as far as I know, Karin will correct me, but for domestic use – the municipalities? No. So its only those who are customers directly customers of Eskom you know they are on flexi or megaflex tariff... or whatever.

Participant 3: Ja. I've been involved in that with Eskom on the farms, years ago but er, I mean surely it could save a lot of power- I don't know what it would cost to change all the meters...

Co-facilitator: Ja, the problem is that its not only the metering- I mean the meters do cost more to have time of use meters- most of the commercial and industrial customers in South Africa and most of [inaudible]...whether its municipality or whether its Eskom, the problem with residential is that its not only a different meter which then logs it, its also that those logs then need to be stored... so it's a huge then software capacity so now instead of your bill having one line, now that bill is gonna have quite a few lines and that all needs to be stored at sort of an hourly levy that needs to be done. So that is actually a lot of data from a lot of customers. So its worthwhile doing it for commercial and industrial customers, but to do that kind of infrastructure for a residential customer- because you then gonna bare that cost of being on that time of use tariff... you know... it costs a lot...

Participant 3: ja.. ok, it costs a lot- its not an option... [Karin and participant talk over one another... inaudible]

Co-facilitator: ... if you just think of it on your computer...you know... either you measure at the beginning of the month or you measure at the end of the month otherwise you're measuring it between these hours or those hours its just- it's a data thing...

Participant 10: I think load shifting or load clipping is a viable option for every domestic user...

Co-facilitator: It's the way we all grew up- you know, you don't put your toaster on when your kettle is boiling and that's that's...

Participant 10: It saves your demand charges...

Co-facilitator: It saves it... I mean we know about that and children these days don't know about that – the only problem is that's negative towards PV because it's going to trip when the sun is shining and you not using and it's the capacity that actually costs the utility to provide you- the utility doesn't mind how many kWh you using, actually it's how many you use at that peak... that's what the infrastructure cost is ... ja so be careful what you're promoting...

[laughs... laughter spreads around the room]

Participant 9: Ja I, so I, I've got a slightly different perspective. So um, there are actually municipalities in South Africa that are implementing time of use tariffs so it's beginning to happen. I agree that the cost is high, but life for me is relative. If I compare the cost of putting a smart grid in the whole of South Africa vs. investing in a 9000 MW nuclear power plant, I think it's *a dimple in the emmer*... and I think that one of the challenges with PV is you generate in the middle of the day and Eskom at the moment has an energy problem but it also has quite a big demand profile problem and one of the big challenges for Eskom is between say 6 pm in the evening and about 10 pm in the evening when everybody gets home from work and switch on the stove and have the nice warm bath and shower and the demand spikes and solar PV is not a great solution for that... I mean, if everyone in South Africa put PV on, we're going to have 0 need for any power plants in the middle of the day but we would still have exactly the same need for power at 7 pm in the evening and you

cannot run the grid with that level of instability, so in my opinion, the correct answer for the national grid is cost reflective tariffs. So the moment the tariff exactly reflects what the cost of generation is, at that time, then people will start either changing their behaviour or they will put in storage systems like batteries to say- like you've explained [indicates participant 3]... lets just say electricity almost becomes free in the middle of the day because everyone has PV, so, what would I do if I have to pay R3 per kWh in the evening, will I'll just charge my battery in the middle of the day and use the stored electricity in the evening or even better with your wife- just make the hot water during the day (don't make it at night) so I believe cost- its like in business in general, you have to have the rules of the system govern what you want the system to do... so let the cost of the energy that you generate reflect the underlying economics and then I think that society will move in that direction.

Participant 6: But you make it sound so simple. Why don't – why they just don't do that? I mean that just solves the whole problem...

Participant 10: Well the whole world is moving in that direction so that's where smart metering... [participants talk over each other- inaudible]

Participant 6: I mean you'd think that someone up there must just realise that and just do it...

Participant 10: as a matter of fact, with the system like that you don't even need PV panels because you've got very cheap power from Eskom during the day- just load your batteries.

Participant 1: The problem is the technology is out there-that's not the issue- the problem is that it doesn't get utilised...

Participant 6: No its actually more of a rhetorical question...

Participant 10: The incumbent Eskom the government is protecting it so at the same time, they want renewables – we all want renewables – but they have a dilemma ...

Participant 5: I have a question on the idea that storage is a separate question... is batteries the most economical efficient way of storing the excess energy?

Participant 10: It's the only one you've got...

Facilitator: Well unless uh, you can in theory go and store that in hot water...

Participant 9: Ja it depends on what you need the energy for. If you need it to heat water then just store it in water. If you need it to power a light bulb, well then you store it as electricity... if you need cooking... well then you've got an alternative. You can store it in a gas cylinder and if you think about it that's also just a battery... if you've got energy stored in a cylinder which I use for my stove... so there are many natural batteries out there that I don't think people are using. I mean like a pool pump for example your pool is also a battery. You know you need to circulate your water through the pump for 6 hours but you've got an option of when to do it. So um, a chemical battery um, is quite an expensive way of storing energy um, and I wouldn't do that unless I have an absolute need for it.

Participant 4: Ja I'm thinking the mechanical- you can have-you mentioned a gas bottle or you can just have a bigger cylinder, compress air into it and then run a compressor from it to generate electricity when you want

it.

Participant 10: Ja there are people doing that...

Participant 4: The question is again capital wise: is it more efficient/less efficient/
more costly...

Participant 10: I think they are just not available at the moment, commercially.
But Guys are looking at flywheels...?

[murmurs of agreement...]

Co-facilitator: compressed air is not very efficient because you have a lot of heat
loss and because if you cant compress the air then the temperature
rises so you know if you can harvest that heat into, say, your hot
water, or something... there are people in Jo'burg who actually
have compressed air storage...

Participant 9: I guess for residential- for us now, you pay a flat tariff so there is no
benefit you can get from moving your energy from one period of
the day to another, and that is what the missing links for the
residential areas is the flat tariff- is there is no incentive to shift.

[Silence]

Facilitator: Alright: any other comments or questions that you have... You seem
to have given quite a clear message.

[laughter]

Participant 4: I think that one of the things we haven't spoken about is on knowledge: if knowledge would make a difference to the uptake of this system, the problem is there is so many possible solutions- if you had 3 or 4 solutions for the problem then its easier to distribute the knowledge- to get information. But with this whole situation- you actually have to get to know your own specific needs are.

Facilitator: Ja I mean in that sense a gen-set is so much easier- you go and buy a gen-set and you buy fuel and you're set but you still need to know how much you're going to use to size your diesel gen-set- now here like you said there is storage options here, different technology configurations... makes a little bit more complicated.

Participant 4: Ja and I think that's part of the problem now, of the uptake is-

Participant 1: It's not user friendly!

Participant 4: All of us here have done research because we are interested, we want to see what the solutions are but if everybody is going to spend that amount of time to see what fits them... they are not going to do it...

Facilitator: Ja. There is no easy, one size fits all kind of thing.

Participant 1: And there's probably, I don't know, maybe you guys know those of you who have actually installed these, um I'm assuming that its not, um, easily accessible readily available, that there are , um, are um, technology vendors out there that you could contact as if you would contact a plumber or an electrician to do this for you- to come in determine what your needs are and tell you this is what you need and here's the system and its ready to go!

Participant 10: You can do that

Participant 1: Easily accessible?

Facilitator: Ja I mean that... that

Participant 1: Or are there a couple in the country?

Participant 10: There are guys who will do equipment for you uh, I guess the workmanship varies, but from talking to various colleagues of mine- we've all had the same problem- they charge you they'll size it for you you- all those things- and then they disappear because they are very busy- they are doing all kinds of things. And then you battle to get hold of them to help you with the settings and so on that you don't like so I've been battling now, I don't know about you, but ...

Participant 1: So maybe the number of vendors isn't the issue but they're...

Participant 10: You must pick the good ones.

Participant 1: The accessibility is still the issue...

Participant 10: Ja but if you find guys who need to come and you can find a good guy with a good reference.

Facilitator: Ja, as you say, I don't think the issue is finding someone to come and install but after- I think this is so much more important here in terms of after sale service. Uh I mean like [participant 10] says... I mean I love playing around with my system but I mean, I'm an engineer you know, but that's not what everybody is going to do. You just want to plug and

play and get on with it. And that.... [Jumbled voices speaking over one another- inaudible].

Participant 5: And then you expect the system to run on its own.

Participant 10: But it doesn't. They need to come back a few times to adjust some of the set points for charging and how deep to cycle the battery and, he knows all about that, [indicates participant 8], they don't come. That's the issue.

Facilitator: Ja but [sigh] you know, they had to come and move my panels as well because then you need to realise there is some capability disjoint in a sense, for example they come and install, or, as an example they don't get guys to come and look at your roof. So in my case there was a chimney and it cast a shadow over parts of the panel in winter in the afternoon and obviously the panels operate at the efficiency level of the least efficient panel...

Participant 1: ... and that's the worst sun availability you have in the whole year so obviously you want to optimise it that time of the year, its not as critical in the summer when you've got the sun exposure for longer.

[murmurs of agreement]

Facilitator: Yes, as I say, what Cape Town has done in terms of the solar water heater by making a list of reputable people who can sell you a system provides some way for people in the country to just provide people with different types of information- on the types of technologies out there and that you're looking for... uhhh... you don't have that here.

Participant 1: No, I mean the the the, solar panel geysers are everywhere. But what about other things? What about my air-con? You know, the other things that I make sure I run but its only the geysers that's there to-

Participant 10: well they are the simplest and just by the way next time have a look at their orientation of the different panels... have you noticed? All the different orientations ...

Facilitator: Ja they just point south and they do it and its great

Participant 10: yeah, I don't know how people do that, I don't understand...

[laughter]

Participant 1: Well, probably you've got installers who just know how to screw the panel down and don't know the technology behind it [another participant: hmm, ja] so, aren't trained in how to align it properly.

Participant 8: Maybe they were European and gave instructions... [loud laughter all round] and they read and think it must be south [facing instead of north-facing]

Participant 10: No no, I think the ones I'm referring to are the RDP houses along the N2 [Other participants: oh, ok, yeah] ... and the guy gets an instruction to fit one on every roof and he doesn't care...

Participant 1: yeah, he just screws it down on the roof, wherever, just on the roof! Yeah.

[laughter]

Facilitator: Alright great I think that was an interesting discussion. Was there any other point or comment or question?

[Silence]

Ok, Im going to ask you to just stay for a couple more minutes... there is a second survey, which is survey 2. If you could just please complete survey 2.

[Silence and shuffling as participants complete the second survey]

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Appendix B: Transcript of Interview with Ms Cabral Wicht

Motherland Coffee Shop
Adderly Street, Cape Town
10/06/2016

The Interview began with introductions and I explained what my research was about. We then got on to discussing what 110% Green is all about. The first question was about what does the 110% Green Initiative do and she answered by providing some notes and I'll expand on this later. The official recording of the interview began with question 2: what is her role in the organisation.

Researcher: Please can you tell me what your role is at the 110% Green Initiative?

Ms Wicht: Ok so I manage the 110% Green initiative, I am responsible for... um... all of the projects and managing the initiative itself. So 110% Green was started in 2012 as... um... when the Green Economy was identified as a strategic priority for the Western Cape Government...um... The decision was taken that... often because business is a couple of steps ahead of government and the private sector had already moved into that green economy space within the western cape and while government was trying to figure out what its role would be within the green economy space, we needed a vehicle or a platform to engage with members of the private sector and NGOs and academics who were already very well aware of that space and 110% Green was then set up as a kind of set up as that networking platform to bring people together, to share experiences and share stories because it was so new and, you know, fast evolving and all that sort of stuff and since then we've got this strategy framework that sort of guides a lot of the work that happens

in this space and 110% Green has now taken on the role of the communications platform for the Western Cape Government to share what we're doing in the green economy space and what projects other people are doing to allow other people to contact each other... and um... so that's also what we do.

Researcher: Do you have events that you bring people together or...

Ms Wicht: Ja so we have a website and we have a twitter page and a Facebook page and stuff where we ... we share information and then twice a year we hold network events where we invite our affiliated organisations and stuff to come together and most often this is around a specific theme and um... what we do... the sort of methodology that we use is something we call communication by doing. So we actually do things as a way of, you know, encouraging behaviour change and that sort of stuff. So... two years ago for a Mandela Day event our focus for that year had been around food, the issue of food waste in our departments so we brought together around 250 businesses and we did a whole sort of cook off, Master Chef type event where we provided ingredients and people had to cook, I think it was a soup, uh... you know, with the least amount of food waste and then that food was donated so... ja we really plan our events. Last year we did a business synergy event where we asked businesses to make donations if that business had a specific waste that could be used by another business as a resource we facilitated those kinds of linkages and that sort of stuff... That's sort of the approach we take to the whole thing...

Researcher: I love the creative and proactive approach you take...

Ms Wicht: Ja, so... people often have this perception of government that its... you

know... boring, so what we've tried to do is to do things differently, because its also a different sort of space, you need to be able to do things differently and work out of the usual government mould...

Researcher: Just to steer back to the PV conversation.... Why PV? Why have so many different stakeholders (Green Cape, the CRSES, some homeowners, the City of Cape Town and so on) selected embedded rooftop solar PV as “the solution”?

Ms Wicht: So rooftop PV was identified because if all the necessary regulations and systems are in place, it would be a very quick “win” in terms of ensuring energy security for the Province and... um... so... um... with the price, you know, having come down so dramatically over the last few years and the technology evolving at such a fast pace, we just felt that this would be... um... sort of a good area where we could get people excited and involved in so like when the Tesla battery was announced, it was like this huge global thing and everyone got super excited so because of the new technology that people are very interested in and we can sort of latch that interest and gain, and encouraging people to become part of... of making a difference in terms of their own energy behaviour and... ja...

Researcher: Ja, I suppose its something that they can do themselves...

Ms Wicht: Yes exactly, it is. Its within their own sort of sphere of influence and they can take control of their energy... because also in South Africa with, you know, issues with Eskom and stuff, people... and load shedding... People felt very powerless and so that is something where they can say “well I can do this and with the encouragement of feeding back into the national grid, I am helping the nation around... um, the energy security.”

Researcher: And when you say “It [embedded solar PV systems] helps with energy security” is that despite issues of intermittency and the issue that you’re going to end up with a lot of electricity in the middle of the day...

Ms Wicht: Ja so... obviously rooftop PV doesn’t solve that issue because, it only becomes um, a solution if people put battery packs [i.e. if systems are not embedded] on and can charge the batteries, and use that energy in the morning and evening when the sun is not shining um, so so...

Researcher: And in terms of grid connected PV where systems are feeding back into the municipal grid and municipalities would end up with a large amount of electricity in the middle of the day- how would that energy be dealt with?

Ms Wicht: Um, uh, ja so it would be through redistribution through the municipal grid also, I know for example, the city is re-looking at... or putting together a whole demand side management strategy... so how can they try and shift those peaks, especially in winter because they present a huge problem for the city so they are looking at a whole lot of different... so like ripple control with geysers so that people don’t have their geysers on during those peaks and water will still remain hot, its just that you don’t have um you know, that additional strain on the grid at those times, um.. so ja, so then the rooftop PV would then provide an additional source of energy and often it would be cheaper than buying from Eskom cos also during the peaks, municipalities are paying – so municipalities are on a Time of Use and during those peaks the energy they buy from Eskom is THE most expensive but if you’re on a prepaid system you’re not

really paying that rate so municipalities are actually subsidising our energy price during those peaks and so then it becomes really expensive for the municipalities... ja.

Researcher: You mentioned Demand side management which links to energy use behaviour... um... in the pilot study I did I found that people thought that they'd consider paying the amount required to invest in PV and they were open to the discussion but when you tell them that they need to change all of their light fittings to energy saving ones, and they need to change their geysers and shift their use and do all of that to eventually realise the full benefit of saving money with the PV system- how have you guys thought of marketing ?

Ms Wicht: So our research, what we found is that people will, at this stage, um, are not willing to invest a lot of money on any alternative energy things- they want to know what is the easy, low cost solutions that we can do and that's why we are pushing energy efficiency so much because it's the easiest things on the behaviour change spectrum that people can do that can save them a lot of money but that doesn't require huge investments, and if they can get those things right, then a PV system starts to make sense. So for example switching down your geyser from 80 degrees to 60 degrees, you know. That can save you a lot of money so you know there are a lot of things that people can do and you know, changing the time of day that your pool pump is run. Many people have their pool pump running 24/7 and its completely not necessary. But of course getting people to change their behaviour is a very difficult thing.

Researcher: Well I suppose you've got to start making them aware of it (the behaviour) before you can show them why and how it could and should change.

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Ms Wicht: Ja, exactly, so yes then its also reinforcing the same message over and over and over again until it becomes sort of second nature for people. So its, I mean, so our communication campaign- we've invested quite a large budget into it because we understand that its that any change is not going to happen immediately- it might take two years to see any considerable difference. But I mean the city has done an energy analysis and what we've found is our energy consumption since load shedding in 2007/8 has been steadily decreasing year on year, um, and I think what the load shedding periods have done is started to sensitize households to the energy issues, um, and so people have become more aware of it and obviously with the electricity price continually increasing and increasing and increasing, it puts a pinch on household budgets and people will make the changes where they can save money so a lot of this campaign is focused around saying "well if you do this, you can save this much money..." and those are the things that people want to know- how to translate – you know: if I do these things, can it be translated into a direct saving.

Researcher: Yes, that's the thing- its got to be "direct" otherwise people are not really interested. [laughs]

Ms Wicht: So ja, that's ...that's... I mean you'll see from the research that I'll send you, that's the way we're approaching a lot of our communications campaigns: if you do xyz, you will save this amount of money over this period to make it very clear for people that those opportunities are there and they don't have to wait 5 years to be able to see the benefits.

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Researcher: So this leads me to the next question, which is: apart from the tariff and the policies and stuff, what else are you doing? You have the communications campaign...

Ms Wicht: Ja, so the communications campaign, because we don't have any set direct role in terms of setting policy or distributing electricity, so ja, we have our communications campaign. And then supporting municipalities where they need.... Um Green Cape- I don't know if you know about Green Cape?

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Researcher: Yes, I have been in contact with them...

Ms Wicht: Ok so they have become our sort of great technical source on a lot of these things so we facilitate a lot of engagement with municipalities with Green Cape and businesses and that sort of stuff who are interested in this and then we do a lot of lobbying with National government and that sort of stuff, to try and ensure that uh, you know, our stance is taken seriously and that we can have our voice heard so that national level... so for example in the LMG (check...) space, because we're one of the few municipalities- uh... provinces in the country that has picked up on this quite seriously um... and we've invested a lot of our own budget into doing a lot of the groundwork and doing the EIAs and that sort of stuff that would be required... um... our role and our opinion in that sort of space has now been heard and is now being taken quite seriously, ja.

Researcher: And just one more question, while we're on the topic... you said Green Cape is your technical arm for the whole process... is there anything that, or um... like another aspect that you feel you're lacking in? or what else would you say that you need?

Ms Wicht: Um... I'm not quite sure... cos Green Cape covers the space quite well, I mean, cos Green Cape... They were set up um to be that link between government and industry and they were meant to ... cos often business feels like government doesn't really listen to them and that sort of stuff, so Green Cape was set up and is funded by government to play that facilitatory role and they've done a really good job in terms of setting themselves up as a neutral space where people feel comfortable engaging with them and and so we use that and so. Like when we meet municipalities around the rooftop PV, having Green Cape in the room as sort of the neutral experts and engineers in this space often gets the message, you know, a lot easier and um, um, ja they've been fantastic... Ja.

Researcher: Ok, Um... ja. [looks over list of questions] Ok so the whole financial model around PV where the resident has to put up the capital to buy the system, put it in, connect to the grid and then sort of reap the benefits in like 10 years time... um... is there... ok these questions are getting a bit deeper now because I've been sitting on them for a long time... I've been going through all of this for some time and I hear the argument for PV, I agree with it to some extent, I think its fantastic but there are two issues that the next few questions are going to deal with. The first is the focus on the higher LSM groups.. which is... well from a developmental perspective I find quite exclusionary in terms of like what are the rest of the residents going to do (or what could they do if they wanted to do something) and I'm not only talking about the very low LSM groups but also the middle

class households who don't have a lot of spare cash but they have some, and they could be convinced to put it into PV- if you play your cards right, and also people who would want to work towards something- whether its PV or just investing in some kind of renewable energy project- like a... one of the things I've found is this thing in Europe called a District Energy System- so I suppose it would be like a smaller scale IPP project for municipalities or something like that and I was wondering whether um... there's any sort of thought or discussion where having the PV branch as an option but then another investment option for maybe municipalities- or clusters of residents to pool financial resources into building some sort of generation system for their own use or in situations where individual household PV is not necessarily viable ?

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Ms Wicht: Um...I mean... I think ... the difficulty we face in South Africa is that because the energy system is so highly centralised, trying to decentralise that is a massive, massive challenge... um... however, um... the City of Cape Town for example, has started to look at what would the utility model of the future look like and trying to see well, does the city for example become an investor in PV and as a city- do they get involved in putting up a whole system that they feed into the grid for the city of Cape Town for example...

Researcher: Would that be on various roofs or like at putting up an actual solar farm...?

Ms Wicht: So, I'm not actually sure what they're looking at but I'm not sure what would be an option- you know in Germany you have the option where you can rent your neighbour's roof, you know, that sort of

stuff... I'm not sure we're at that stage just yet, um I think also because...

Researcher: Would you think reaching that stage would be possible?

Ms Wicht: Um... I don't think its impossible, I think what we've been encouraged by is that um... the city is open to hearing these suggestions and so, um, for example, Green Cape has put forward a very good business model on what different utilities of the future could look like um and these are being considered quite seriously so, um it does mean that um, that the municipality is considering it and, I mean, I think they're aware of the fact that if they don't, they are going to get left behind and its just going to get more and more difficult as um energy, you know, constraints continue, people are just going to go off the grid and then you lose... you know... so its better to take proactive steps now... and maybe take a little bit of a hit on your revenue but in the longer term it will be much more beneficial, um, I do know that there are neighbourhoods in Cape Town that are looking at themselves going off the grid, so I think I've heard like the Kommetjie-Noordhoek area rate payers association is looking at taking on that model- similar to that suburb in Johannesburg that went off the grid and that I think is a worrying time for municipalities because you don't want... cos they will be your high energy users and you don't want a community like that, who can afford PV, to all of a sudden, drop off the grid cos what they're paying for energy cross subsidises what lower income households are using so if you lose your main income source, you know, it has a huge ripple effect... so um, I think...

Researcher: You almost need to harness that project and say "this is a great idea guys but feed in, you know..."

TIME STAMP 00:19:01

Ms Wicht: Exactly, exactly, so... I think that's the stance that Municipalities are taking: lets start looking at what options would be available... I mean they've been definitely... they've been keen to buy from IPPs and you know, it could be more than one IPP or it could be one big IPP, um, it would, that would... um, if we could get the go ahead and do that for the municipality, that would be a open market process where people would bid and that sort of stuff so um, so they're definitely um... are looking at it so if we can get it right in the city, we can, you know, then replicate those processes for other municipalities... ja.

Researcher: That all sounds so cool and interesting

Ms Wicht: [smiles] Ja, it is...

Researcher: It's great for me to get passed my own mental blocks about this stuff and hear what else is happening out there..

Ms Wicht: Ja, so it might be worthwhile for you to speak to some people from the city... and to see... and to speak to them directly cos they are looking at a lot of different things... there is someone in the Electricity Department who is solely responsible for Green Energy alternatives and I can give you his contact details, um, ja and I'm sure he'll be open to chatting to you.

TIME STAMP: 00:20:14

Researcher: Thank you, that would be fantastic! I should've met you a long time

ago- this interview really has been very helpful.

Ms Wicht: [laughs]

Researcher: Ok so we have covered: ‘what are the challenges to the uptake of PV’, Now, about Drakenstein and the City of Cape Town and their feed in Tariffs, Drakenstein has a really nice tariff. Do you know if they’ve seen a particular increase in the uptake of household PV?

Ms Wicht: So the numbers we’ve gotten from them, I think they had 37 PV applications so its very... its sup-... and we’ve been surprised by that. So we’re not sure whether its because they’re just not communicating that they have this option available, to, you know their residents and the businesses in the area and we’re not quite sure why, but we’ve just received those stats from them a couple of weeks ago so. My intention is to go and meet with them and, and see you know, why has their been such a low uptake and how can we start improving that in the municipality.

Researcher: Yes, they’re actually my next stop after I’ve met with you I plan on meeting with them so if you plan on going any time soon maybe I could accompany you?

Ms Wicht: Cool, alright, ja well we’ll see when- I think we’re only aiming to go at the end of this month or July so we’ll see what happens because also at this stage with municipal elections- it makes it very difficult in terms of engaging with municipalities also because the outgoing administration is unlikely to make any drastic changes and then at least for the first 6 months of the new administration they’re unlikely to... so... it does pose a challenge to us because then you’re almost knocking out a whole year because of, of the change over. We are

sort of being a little bit hesitant around the municipal space, I mean we care continuing and Green Cape are continuing with their engagement and stuff but as Government we're just, playing a watch and see sort of a game.

Researcher: I'll go just get some insight into what they think about the situation..

Ms Wicht: Ja, I think that would be better and I'm sure they'd be happy to give you that because we do come in and speak to them a more senior level but overall I would say this is a bad time for us to set up meetings..

TIME STAMP: 00:22:53

Researcher: Ok, so we have spoken about social research that you've done already, and we've spoken about why PV and this financial model, and um... ok other than a tariff, do you foresee any way... ok so the idea is that once the market takes off, prices will come down, but we're struggling to get the market to take off... um, and the feed in tariff is supposed to help with that?

Ms Wicht: Ja, to encourage people to take up the systems...

Researcher: How else do you think the market could be encouraged and how can you guarantee that the prices will come down?

Ms Wicht: Well at the moment, PV is still dependent on imports from overseas which is one of the huge barriers so, the price of PV systems is often dependent on the dollar to rand fluctuation and it has been fluctuating quite dramatically um, so ja, so that does pose a problem that we have very little control over unfortunately, so um, but I mean what we've been trying to do... and a part of the wider green

economy work is to make the Western Cape a attractive model- uh- province for businesses to invest in and set up factories here to produce PV panels locally and that sort of stuff, so I believe um, that ,um the Green manufacturing hub at the Atlantis SCZ has just been approved and that would mean that if your business is located there, they get all of these government incentives as part of an industrial development zone like cheaper electricity prices, you know your taxes are reduced and stuff so it makes it an attractive space, so, through Green Cape and through our investment arm: Wesgrow, they've been doing a lot of work to encourage a lot of international businesses to come here, and when the REIPPP programme took off a lot of those businesses actually did and the Western Cape has been a preferred location um for setting up their businesses so we've got a lot of international players like Gestamp and that sort of stuff who are based here in the Western Cape but unfortunately at the moment a lot of the different pieces of the PV panels are sourced internationally, they haven't quite go to the stage of local manufacture, and even with the local manufacture... Green Cape did an analysis and um with the ERC on the REIPPP Programme and the REIPPP Programme did have a percentage mandate for local manufacture but there are ways that, you know, you can get around it and that sort of stuff... so I don't think it's worked to the degree which it was hoped it would've worked so um them setting up the province as a good place for investment is then the next step and then through SARATEC, the um training- the South African Renewable Energies Training College, um, you hoping then that you can start up-skilling the work force which is then the next thing for businesses- you know, if they can see that you know you've got the work force to do those sort of jobs then it also helps with that.

TIME STAMP: 00:26:11

Researcher: Then in terms of the resources that you'd need to make things like PV panels, is it possible to... I mean, is there any particular thing that we have to import?

Ms Wicht: Um, I'm not too... Ok on those sorts of technical things, I think if you, maybe direct that question at Green Cape, they would be better in a better place to be able to answer that question... [laughs]. Um, but I know, I mean there are a lot of... I don't know if you've heard of SAREBI- they are a local business incubator and what they do is they've got a whole business space and they take local companies and they hold them for an incubation period until the business is up and running and support them that sort of stuff, so they've been doing a lot of work in ensuring that local businesses have the capability to cover all the necessary components you know they take them through the testing process in their factory and you know all those sorts of things which makes it a lot easier as a start up because then you don't need to carry those costs on your own um and so so they've been doing... they've been doing... they've got this massive factory space and its got all the things you need to test the different components of solar water heaters and LED lighting and all those sorts of things and they will so other... and they will also do on the administrative side of businesses so they will host your website until you're up and running and assist with, you know the financial management until the business can sort of do it on their own so it's a sort of hand holding business development process, um which has so far seemed to have worked quite well... ja... so there are a lot of those things that are trying to improve the market and if we can try and get that going and PV manufactured here, then hopefully, um... that will bring the costs down. So I know Mike from Green Cape was telling us that um, one of the guys from UWC has just started a

business where they're developing um... a battery pack- locally- um, and so that will... and... apparently- according to him its better than Tesla and if you don't have to pay the \$14 or \$16 000 for a Tesla battery pack, you know, its starts making those sorts of things very attractive for the local market. So there is a lot of space happening and I think what's cool is because the Western Cape is seen as a good space for those sorts of industries, they're taking off quite rapidly, and because we have the different universities that are investing in research and development in those sorts of spaces, it does make it very attractive.

TIME STAMP: 00:28:53

Researcher: Yes, definitely. Do you know of any equivalent to an organisation like 110% Green in other provinces? Or cities, like JHB?

Ms Wicht: Um... no, and I actually have been contacted by other people on a regular basis from other provinces saying "cant we do... cant you help us with this" and I'm always like "I'm sorry but unfortunately my mandate is within the bounds of the province so I know for example that KZN has a Green Economy Strategy but I'm not exactly sure how far they are with that... and I know Gauteng is also um... and Pretoria specifically... um... Tshwane... they're pursuing the Green Economy quite hard... you know with REIPPPP it was always a bit hard to... for businesses to decide where they were going to be based- between Gauteng and the Western Cape and the first few rounds of REIPPPP was dominated by the French and the Italians and the Spanish and that sort of stuff... and for them the choice was also quality of life and so as Cape Town we had that added advantage and um, it was pushed really hard and so, ja it worked in our favour. But ja, I am not aware of any other similar

organisation out there.

TIME STAMP: 00:30:47

Researcher: So I see on your website you actually have a solar design lab coming up soon... What's that all about?

Ms Wicht: Oh, that's actually from last year, it should've been taken down by now [laughs] I'll do that when I get back to the office. But basically in order to decide the focus for 110% Green we held design labs with technical experts and businesses and officials and that sort of stuff and then over a period of two days... and um... what we are implementing is as a result of what came out of those processes. So ja, we haven't, as Government, just gone and thumb sucked what seems like a good idea, a lot of it has been based on input from the private sector and academics and that sort of stuff to make sure we are actually putting our focus and our budget on the right things. Ja.

Researcher: Ja, that's good... Ok well thank you, this has been very helpful for me...

Ms Wicht: I am very glad!

Researcher: I just have one last question: you've helped me so much and I'd just want to know whether there is anything that, as part of my research, I could do to help you, or whether there is anything in particular you'd like to know as part of the process?

Ms Wicht: Um, I mean I think we'd be very interested to find out the results of your research cos that would definitely be able to assist us as part of

our communications campaign and as part of our focus- if we can understand what people are thinking, we can then focus and direct and design accordingly. So, um, I mean I can't think of anything specific now off the top of my head but I mean I will keep it in mind and if there is anything that comes up I will let you know. It definitely would be great to hear about anything you find along the way that you think would be interesting enough for us to know about, ja, if you keep us updated that would be great.

Researcher: Cool, I'll do that. And thank you so much once again, its been great.

Ms Wicht: Cool, you're welcome.

Appendix C: Transcript of Interview with Mr Brian Jones

Transcript: Interview with Brian Jones

Date: 1 July 2016

Time: 12:00 pm

Venue: 4th Floor Electricity Services Headquarters, Bloemhof Street Bellville

Greetings etc. Done

Brian Jones fills out consent forms for interviews etc. Asks some questions pertaining to the document: e.g. Will he have to participate in a focus group to which the answer was no. The document explains the research topic and focus etc. so no need to bring it up again immediately.

Conversation progresses to interview (atmosphere is relaxed not overly formal)

Researcher: Karin Kritzinger [one of my supervisors] said that I should speak to you to get a better sense of what's happening in terms of planning for solar PV in the Western Cape and um, I suppose we can start with discussing what your role is here and then I can tell you a bit about what I have found from doing this study so far-

Mr Jones: Ok. My job description is "Head of Green Energy" and it isn't any clearer than that... so... I try and facilitate green projects for the city although there is very little legislative mandate for the city to get involved and one of the major projects I've been involved in is um coordinating the multifaceted programme to allow rooftop generation to be connected legally to the city's grid and... um... where people can get a limited um credit for excess energy that goes onto the grid. And its just multidimensional because it involves the legal aspect, the tariff, the business billing systems, um rules, metering,

equipment... Ja, so that's me in a nutshell.

Researcher: Hm, that's quite a big "nutshell." So do you work for the City of Cape town?

Mr Jones: I work for the Electricity Department of the City of Cape Town, ja.

Researcher: Ok so it's for the Municipality and not for the whole of the Western Cape?

Mr Jones: Ja. That's right

Researcher: Ok. So when you say you have been working on the project to facilitate the uptake of solar PV for the municipality, is it part of a "grand plan" for energy development in the Western Cape?

Mr Jones: Ja- Look, Um... (sighs)

Researcher: ...I ask because I have been looking at what is happening and it seems to be very.... almost reactionary in terms of...

Mr Jones: Ja! It is.. um a lot of people... you know there is no legislation... the electricity supply industry is highly regulated and you cant breathe without having some law telling you what you can and can't do and um, it goes back to the electricity regulation act and there is nothing in law which gives any direction as to how you handle small scale embedded generation and the National Energy Regulator has been working on a set of rules, um, and they should've been issued about a year ago or so... but they haven't been so we just felt that we had to put something in place from an electricity distributor point of view so that... to... sort of stem the flow of people connecting illegally to

the grid- to Eskom's grid and to... throughout the country um so it is reactionary from a electricity perspective... um but the city also has a strong sustainability drive and um, and it has.. the city... from many different angles would like to see um... PV proliferate from the job creation point of view... and the economic benefits of that uh... from the climate mitigation point of view... um... uh, ja and from you know... kind of the green image of the city as a destination for investors is just multidimensional so you know there are challenges to electricity revenues as with energy efficiency and it kind of upsets the apple cart just in terms of the way scientific knowledge has been applied in the past to the distribution of electricity because all of a sudden you've got something that is completely unpredictable and um and really disrupts operations in many ways so... ja... it's been a big learning curve. It hasn't been resisted in any way but it has been, I would say a bit reactionary from ... or... ja. [pause]. And I would say "reactionary" because there hasn't been legislation in place to guide- you know?

TIME STAMP: 00:06:03

Researcher: Yes, it definitely seems like there is an idea of where we want to go, and then there's... who is it do you think who is driving the uptake of rooftop PV? Do you think its residents or organisations like Green Cape or...

Mr Jones: I think it's suppliers of PV equipment- people who are trying to make a living...

Researcher: That's interesting...

Mr Jones: Ja...

Researcher: Because (and I'll get into the details of it later) but when we spoke to residents, um, there were a number of reasons why they would want to put in PV-

Mr Jones: Ja look there are a handful of some "greeny" residents and there are some residents who would like to make some sort of... what they think is... (and I sound a bit cynical) it's their religion and they want to make some sort of "meaningful impact" on their lives and... uh you know... so you speak to them... and they've kind of been pushing it and trying to get their names into all the journals- particular individuals- but I think the big push has come from suppliers- I don't think the... ja that has been the big push from my own perspective. I mean one or two individuals like to take the accolades but its been coming- I mean the prices have been dropping and the Eskom prices have been going up... Um.... It still makes a lot more sense to spend money on a solar water heater than on PV, You know? Depending on whom you speak to... I know Stellenbosch have got ideas around their certain case but...

TIME STAMP: 00:07:50

Researcher: Ja- I've been looking into this now- I think I started in 2014- and I've been trying to convince myself that PV is the best option -because most people I speak to (those from the CRSES and from Green Cape, the Energy Game changer with 110% green) and my supervisors think it's the best option but when I've spoken to people [residents] and when I've actually looked at the complications around installing and managing your electricity use and the fact that people don't want to research this in so much detail, and they just want it to work like electricity from Eskom... and then you tell them that they need to

retrofit their house to be energy efficient in order to get the best out of their PV system, BEFORE they have excess to start selling excess electricity to the grid- they come to the conclusion that that's actually too much work, so I don't understand... why PV? And is it the ONLY kind of Small scale energy generation we can look at?

Mr Jones: Ja look I think it is at the moment and I imagine, you know there is so much sunlight energy around its just astounding so we should make use of it. But I think what is going to be the game-changer completely is when cheap storage arrives and that's ... and storage is following the same price trajectory as PV you know, which has reduced to something like 20% of its cost 10 years ago, now storage is going to follow that and storage is going to completely turn the industry on its head. Except that, particularly in Cape Town, it's a bit different to the rest of the country- we get days on end where its cloudy and in Johannesburg they get more sunny days in winter and the temperatures are lower so the PV panels are more effective and I have heard that they can get more out of their panels on a winters day than on a summers day because invariably in summer they've got rainclouds that appear in the middle of the day, every day so, so cape town is a bit different, you know? I think, uh, one... I don't know what the price of PV is going to be- I think it's quite an efficient solution to just have a PV panel rather than having PV and a solar water heater um- and then the energy goes into your geyser anyway um, I just um... you know... I haven't seen any kind of financial modelling, um, there are people in Stellenbosch particularly who – the university- who have looked at specific cases and have seen that “ well its cheaper to just dump the energy straight into your geyser via an element” ... uh... I don't know if that is true or not um, or if it's true for the whole broad spectrum or is it just a very particular application... but certainly I ...(sighs)... you know... I... hot water

is a type of energy storage and it's a very cheap type of energy storage so there you go... instead of getting batteries, why not just use... you know. So maybe if you're comparing it to batteries it makes financial sense, um and I don't know what they've taken into account, but certainly you know it's a fantastic form of energy storage so... maybe an area that needs to be investigated more. And batteries are coming down anyway but er...

Researcher: But batteries are not really “green” so... maybe not the best option for the “greenies”

Mr Jones: No, not necessarily- it depends on the type of battery – there are batteries now that are very green, you know, I think compared to like lead acid or um there are you know, Tesla batteries , you know the people working on Aluminium Air batteries (now I don't know what goes into an aluminium air battery) but it sounds pretty benign to me- particularly compared to nickel cadmium which is horrific. So there is such a huge amount of research being done in batteries what with nano-carbon, you know- there is gonna be just amazing stuff arriving hey. Like and Tesla's car battery is sort of old technology already. They will keep up with trends but there are people with far better batteries than the Tesla battery um, at the moment so it's a very interesting time and space that we live in so I mean... to make a statement on it: I think PV is the future but PV with storage. The storage makes it a lot easier to manage on different levels. Whether its on residential or utility scale: PV plus storage I think is a fantastic combination but it doesn't solve the problems in winter in Cape Town and this is the challenge. Now we've still got to supply peak power in winter over a network that cant handle it after a week of clouds and the batteries are all flat but now we not selling electricity the rest of the year so how do we recover money to pay for the

network that still has to be as strong as it had to be before PV arrived because your network still has to provide the same amount of energy as it did before but you're selling less energy so cost recovery is going to become a big issue, um, for all utilities and how you manage to fund the network and I imagine that the only way to do it in the future is the same way you fund roads: that is through general taxes rather than through an electricity tariff. I can't see their being any other solution in the long term.

Researcher: Ok. So when you say "storage will pick up and PV will pick up," then the whole feed in question is going to become whether or not people are going to invest in excess electricity if they're making and using what they need and storing their excess for future use, there is no excess to feed back into the grid.

Mr Jones: Ja, ja so people don't really want to feed back into the grid because we can only pay what we are paying Eskom and its like- I was just working on Tariffs now- a large user of electricity, including VAT, will pay three times the amount, um, when he's on his second block (we've got different tariff blocks) so three times the amount for electricity to purchase it than he would get for um... any refund that we could pay so the incentive there is to consume all your electricity so with batteries, um, that obviously gives you more opportunity – your return on your battery investment then must, depending on the size of the consumption of your house, must be compared to that 228c per unit you were paying rather than getting 78c for any excess. You know? Rather save 228c than 78c. But you still want a good connection for the days that there's no sunshine. You still need it.

Researcher: So then how is this whole 'Feed in Tariff' expecting to increase the uptake of PV?

Mr Jones: Well... its not. It's not designed to... except um, the issue is that people... let me find a pen [draws out consumption peak]... your residential peak, you know, *[goes on to explain the tariff is to incentivise load shifting and to enable customers to size their systems a bit bigger to have the capacity to meet winter demand and have a way of getting rid of excess electricity generated in summer- to sell it to the grid so it is not wasted.]*

Researcher: ...because they're using more of what they produce instead of paying the tariff for electricity during the middle of the day AND by shifting their load from morning and evening peak periods they are not paying the higher tariffs for those times.

Mr Jones: Ja. So I mean that's one of the kind of- unintended- benefits of the way the tariff is structured encourages people to switch their swimming pool pumps on in the middle of the day instead of at night and also to use dishwashers then and so on. So it lowers that peak and it's that peak that the country can't supply. The richer people therefore have more flexibility regarding their loads so what we are trying to do is accommodate people for a limited amount of feedback so they can size their units larger than they would have sized them and they can feed back um, onto the grid and get a fair... it's not an incentive... they can get...something. If they were to get a huge amount of money for that- then the money has to come from somewhere, and if we're paying a lot more than we pay Eskom then the money has got to come from somewhere- either from the other rate payers that don't have PV, or from Eskom, or from somewhere- it just doesn't come out of the sky, you know? So that's why we just can't and we're paying what we would've paid Eskom. So its not an incentive. The facility to be able to feed power back onto the grid means that you

don't need batteries to absorb that extra power so it means that the whole installation will cost less so there's sort of that indirect encouragement for people to connect sooner because they don't have to incur the huge expense of the battery. That's really the incentive. Its an indirect incentive, its not a direct financial incentive. Its indirect because it enables people to install a bigger system than they otherwise would have. Make sense?

Researcher: Yes. Makes sense to me. Um, ok so are there any other ideas for small scale embedded generation so far.

Mr Jones: You mean technologies?

Researcher: Technologies/ systems/ combinations of technologies for systems... um, because what I have found in my literature review I found that they have this thing called a "district energy system" with smaller scale generators that supply smaller areas/ groups of customers but its not central. Do you think there is potential for this idea in South Africa?

TIME STAMP: 00:19:57

Mr Jones: Ja... I think one of the issues is that there are so many consumers who are cross subsidised that we just can't let certain wealthy areas just become completely independent on their own- that's the issue, you know we were approached by a land owner in Scarborough and they want to become independent and firstly what happened is... we've got our network is there and then you hand over the network to them, and then they don't manage it properly, and then the whole thing collapses because for whatever reason for example theft is rife or a big storm comes and takes out everything and then they come to you

“oh they’ve got no money” and they come wringing their hands and then you’ve got to “fix it” and it’s the rich... you know in our economy- I don’t think its going to work.

Researcher: Ok, so that leads me to my next question: with this PV is also very much geared towards the rich- it gives them another option to fall back on for when they are sick of dealing with load shedding and they want a bit more control over their own systems-

Mr Jones: Ja... I wouldn’t say “geared” it just happens to be that way... but it was not designed to be that way, you know? You could say motor cars are geared for the rich as well.. its just because of the inherent cost of things... ja.

Researcher: Ok, but if you take a long term perspective in 20-30 years time (as a sustainability student) I have to ask what the implications of having everyone who can afford to go off the grid with PV would be?

Mr Jones: That’s unlikely to happen in Cape Town because of the weather... but sorry, you were asking what alternatives are there... let me just answer that quickly... I think, just to answer that, I think bigger companies are looking at a kind of hybrid system with diesel back up... um... residential people... ja there isn’t really that opportunity... you know? Some residential people want to put up wind generators, I think they don’t make sense, and I don’t see opportunity for their prices to drop radically- its like motor technology, its not silicon valley stuff. Um, and the wind regime in an urban area is very turbulent and you don’t get much because of that change of wind direction and the effect of the buildings unless your wind turbine sticks out on a tower like this outside here, you’re not going to get much wind and I just can’t see Cape Town with

every single house having a 15m tower and residentially its not going to fly... and... who knows? You know what is in the future? I mean the future is completely open.. [continues imaginings of amazing new technologies that could be developed]. There aren't any new emerging technologies that I can think of for producing energy other than PV and from energy storage through inverters. Maybe one day they'll be handing out mini nuclear pebbles... [continues speaking about thorium... irrelevant]. At the moment PV is PV- you might have heard me quote this before but "the amount of sunlight that falls on an area that is 6km x 6km so with a total area of 36km squared is equivalent to the total winter peak demand in south Africa. So you can't convert that but still 6km x 6km is not a small area. Its just astounding how much solar energy there is that we should be using it! Ja. And its just cheap storage that's just the issue... and the fact that you have to do something if there is a couple of days of no sun, you know? And I think natural gas on a utility scale as a back up would be an ideal um marriage for renewables because by its nature it can follow changing load very easily- things that nuclear and coal stations can't do. So its much more flexible.

Researcher: Yes and that would mean less energy would be wasted etc. Ok so this takes me back to the question about long term planning. This is should happen more at national level than at municipal level but if you look at the how China, for example, plans their development: they will take a 20 year perspective and look at the needs and then work with researchers to achieve those goals. Why is South Africa not taking this kind of perspective? Because currently the direction in which the country is heading with regard to renewable energy or at least any energy planning at all is unclear.

Mr Jones: Because of incapacity in the Department of Energy.

Researcher: And what do you think is the cause of that? Is it to do with a lack of will, or policy.

Mr Jones: I think it's a lack of capacity... I don't want to be quoted on more but I'll say it's a lack of capacity. Generally, I mean I'm not saying everybody but you know I think it's widely recognized, unfortunately. I think it comes down to that.

Researcher: Ok. Let's get back to the topic of solar PV and I'll tell you about my study. My study began with the aim of promoting the uptake of PV. I started back in 2014 when they [the CRSES] was still um, motivating for a Feed in Tariff from the Stellenbosch Municipality, um, and now we have the tariff so initially the thesis question was: 'if there was a tariff, would people be more motivated to invest?' Initially I was going to do a survey to look into this issue but actually I then ran into a whole bunch of difficulties with creating a survey about that (for example: its difficult to get people to answer a survey on something they know little about, or have limited understandings of-

Mr Jones: Well with all due respect that's like saying "if a pig had wings could it fly?" because there is no money- you can't get that tariff there and it makes it a moot sort of exercise.

Researcher: Yes. That. And also one can't predict human behaviour. They'll say one thing and do something completely different. So that is why I have been stuck in this place for so long because I realised that asking questions like this is not helpful because you're not going to get answers that you can work with. So eventually, in June this year the municipality of Stellenbosch released a draft of the policy with a

suggested tariff and that's now out for discussion and um,

Mr Jones: With a suggested tariff?

Researcher: Ja. I think they have been working with Green Cape.

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Mr Jones: But you still have to find the money from somewhere... you know? You can say "I'm going to give you guys a hundred " I mean that's unrealistic... but we will pay R2 per unit, but where are you going to get that money? Half of the residents aren't paying, the other half are stealing electricity, the nontechnical losses for every municipality are going through the floorboards there so they are short of money anyway. Where is the money going to come from? Again, its like a theoretical exercise: if a pig had wings how big must its wings be and how fast could it fly? You know: you can say "alright you've managed to work it out" but at the end of the day pigs don't have wings and that's the issue.

I think the only opportunity there, and old Tobias- if you've come across Tobias from the CSIR, he is saying that uh, Eskom are collecting Tariffs which (you now we have all these big wind farms and PV around the country) and Eskom sells electricity to everybody and in that tariff that they sell, they are recovering costs to pay for the additional premium which Eskom is paying for that energy from those wind farms, ok... That's assuming that the cost of electricity from there is more than the average cost of electricity that they produce from coal... So what Tobias is saying that we've got an opportunity here: instead of say, 79c per unit that Eskom is going to pay (and that makes large PV financially viable) [draws diagram on

piece of paper). Now, what Tobias is saying is that some of that 79c, say, I don't know, 19c of that is got to do with interest on capital because there is risk and so on and these things need to be financed... so part of that cost is capital repayment and part of it is paying the creditors back and so on, now, what Tobias is saying is because householders aren't faced by that kind of risk, if they put a PV onto their household bold, they, say, are only going to be paying, say 15c um for capital (now I'm just using that as an example). So you should be able to go and buy the same amount of energy that you're paying for from all of these large scale wind farms from households and pay them 79c and and... you can divert that money (and he had a scheme) where some of that 79c goes to the municipality to cover loss of sales and some to the householder for excess generation so the householder is making money firstly out of the fact that he's not purchasing electricity because he is now generating it (so that's his one return on investment) plus he is getting more of a payment for excess energy than he could get it from the municipality. So what you are doing is you're amping up the economic development in the area because instead of one wind farm you've got 200 000 installers putting PV on local roofs and so on, you know? Which is good for the economy and that's the only real possibility of a source of this feed in tariff that you're talking about.

The issue is: how do you do it efficiently from an administrative point of view? Because now you need to know how much a guy has generated, you need to make sure he's there and his PV panel is actually there and that the municipalities aren't now claiming their portion from PV panels that don't exist (they just kind of scamming the whole system now) ... you know? When you start looking at the practical implementation of a system like that, it just uh... maybe it

can be done but its not... er... its not that easy and its not easy to make that practical implementation to do it cheaply enough to beat a large scale price- I mean that sort of gut feel. So-

Researcher: So you'd almost need a third party to manage the whole thing?

Mr Jones: Ja but Municipalities don't wan third parties fiddling around with their meters because their meters is like the arteries... that's the problem.

Researcher: Would Smart Meters help? And then you just give said third party access to the data?

Mr Jones: Ja, I suppose.

Researcher: But then everyone would need to put in a smart meter and that's at an additional cost?

Mr Jones: Ja... its more than smart meters and this is another issue:

smart meters need a... its one thing to have a smart meter, it looks like a meter, but you need to be able to get that information back from ALL of your meters, in a secure manner, to a central place. Now THAT'S the challenge: what communication medium? Again its got to do with what that smart meter is required to do? Is it only metering data or do you want to use it to do residential load management? If you want it to do residential load management, that means... ah and there are different ways of doing it... you'd need time of use tariffs maybe? But what happens and you get an emergency now and you have to tell them to switch off? You want to force it... so you need to be able to send out lots of signals- hundreds and thousands of signals very quickly, um which like really loads that communication thing down. And then you want a

communication medium that is open source so, you aren't tied into one particular supplier who sells at a very good price in year one and then he just like makes it 10x more expensive because you're completely stuck with all his equipment, so you need an open source and then just practically... do you use radio? Now radio... if you use cell phones or radio they don't always reach every meter because of steel and concrete and mountains shadowing the thing and so on so you have to get... and now you wanted to get it to everybody so then what they do is... and this is the practical reality... they talk about the "last mile" and they have a concentrator somewhere and that concentrator then communicates to a couple of households, say 20 households, alright, and then they might have some... I don't know... optic fibre or maybe some dedicated radio something but the most emerging technology is power line carriers that you can attach the signal to the cable that goes to the consumer. Now for that to be cost effective, you can't just have one in a suburb here and one there, because you want to fill this concentrator up and make full use of that equipment with as many as possible. Now to do that, you have to have like a big bang approach and I mean that costs an enormous amount of money to ... so how do you incrementally roll out smart meters in a way that isn't going to kill you financially because of the demands of the communication network which you're putting in to speak to it. And then, if we haven't solved that, from a city perspective, you know and all these other municipalities that are doing wonderful things and you go and you scratch beneath the surface, you find that they are nearly bankrupt because they haven't got a clue you know?

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Mr Jones: So Cape Town's approach is conservative... I get concerned that we

generally are power engineers, we're not modern cell phone app, data... and I think... I just get a feeling that we have to be very careful that we don't get overtaken like cell phone companies have taken away the business of Telkom. We have to be careful that we don't get caught like that but also not just run ahead and shoot ourselves in the foot by rolling out systems, which are premature.

I hate it when people quote one failure as a reason for not doing something- the Nuclear people do that with renewable energy all the time and it drives me nuts. Um but Blairgowrie in Johannesburg rolled out a smart meter system which worked on radio frequencies and it was fantastic and the day they switched it on, they discovered that the radio frequency that this thing operated on was the same frequency that opened all the garage doors and all the front gates so now the whole suburb of Blairgowrie had their doors going up and down [laughs] and all the gates were opening and closing- the whole thing was just a stuff up that just amuses me [we both laugh some more]. But it also has to be hack-proof.

Researcher: What I find so interesting about this whole thing is one way of unlocking this whole thing is through developing the communication system and not necessarily by developing a new renewable energy technology system or necessarily through a tariff...

Mr Jones: Ja. In secure communication. Its more in a secure communication than in the Meter I think.

Researcher: And then data storage...?

Mr Jones: Ja, also something to consider but I don't think that's the biggest challenge because there is so much data going around... I think

managing handling the data coming in... and its also the whole functionality of the data and what it does needs to be considered- its not just the measuring reverse power feedback, you know? The potential for smart meter feedback is... <yusssussss> um, is enormous and it goes far beyond electricity. You know if you have a fast data link, a secure link into a household, you can do... there are companies starting to offer a variety of services- you know you can offer cable TV, you can read a water meter, you can control electricity and lights, you can have security services, you can have online education for the kids, you can remind someone to take their TB tablets every day, you know... health education...just but we are ring fenced- we just kind of think “electricity revenue and electricity” and water is doing their own thing and if we could just somehow get a system in that could do everything, you know, yussy, the benefits... and that’s probably why China... Hmm, I don’t know how they make rules... (jokes)... but it works. So I don’t know if we are heading anywhere helpful but its interesting.

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Researcher: I find this very interesting because a lot of people I have spoken to prefer to stay on the same old “electricity” pathway and no one has suggested any other options- even just to talk about them... um, ok so anyway back to the study that I did, which now seems quite small, um, I was saying that they wanted me to find out if people would invest if we had a feed in tariff, um, but then I decided I wasn’t going to do a survey because it’s not going to work, I’d rather get um, well first I found that there is a lack of public communication or communication with the public in terms of what is actually needed and for example what you’re saying to me know is that if you trace the need back it comes to a need for a kind of communication

system...

Mr Jones: Ok well the smart meter or communication system is a barrier to entry [of rooftop solar PV] and ... ok lets just talk about the barriers to entry: 1. Prices coming down but its still very expensive compared to putting in a solar water heater, and a solar water heater can help recover up to 60% of your energy usage in a household, right then you start saying that your PV panel is not supplying electricity for your solar water heater, then your PV panel is supplying energy for that other 40% of consumption alright so the water heater is a lot cheaper in theory (I don't know, that might change) but now you firstly have to get as efficient as possible...

The big driver for PV, sorry, was this whole load shedding thing- Now I don't think that people thought through it properly but to become independent of the grid you need batteries and then you have a couple of days of winter- that's when load shedding is more likely to happen, and then you suddenly realise that you should have bought a petrol generator because its easier. And then all of a sudden Eskom decides that they don't have load shedding anymore- now you're sitting with batteries... which cost a fortune and they just... going to sit there.

[pauses... laughs]

So that was a big kind of driver...

Mr Jones: And people love to hate something, and they love to hate bureaucracies and they see that Eskom CEO is getting R40 million bonus and they decide no- they are going to go off the grid because, you know, its kind of not a rational thing, its an emotional thing so, uh,

I think guys particularly like gadgets and... I'm not saying women don't but... there is kind of a sexy gadget aspect to having a PV system- people like tinkering around with it... and it's a real interesting aspect to getting something like that going, you know?

Researcher: Just as a side note: It was interesting to see who showed up for that meeting that I held- and there was one woman who came out of 10 so that could be an indirect barrier also.

Mr Jones: More barriers are that you don't have wiring codes so you have to get a professional engineer to come and sign off the whole thing and that costs money um, a barrier is that we haven't rolled out a cheap metering system yet so they'd have to buy a new meter at R2000- but then is that a big barrier is you're putting in a R60 000 system?

Mr Jones: I don't know... um, I think a similar kind of barrier, and I think that this is what you're looking at is I haven't got a solar water heater and I haven't got a heat pump, and I have a price for a heat pump but we also don't have a swimming pool, we've got 4 people living in the house, two teenagers and we're using less than 600 units a month, so I don't think we're going to make a huge amount in savings by putting in a solar water heater and just from a financial point of view you know? But If I wanted to put in a solar water heater, do I know what kind of solar water heater? Do I want to put in a flat plate or tube or coupled or decoupled or do I want a closed coupled...? I don't know? Or a heat pump? I don't know...! And and, and we know that some units don't last so long and you've heard of units that don't work properly and sometimes people hear about a success story but normally people don't talk about the success stories, they talk about the failures so... and I'm a technical person, you know so... you've got a housewife... uh... who is a non-technical person... house-father,

whatever, husband... [laughs]... you know... how do you make a decision and every, every supplier you're talking to is telling you "no no no, that's nonsense, that guy is lying to you... my stuff is the best"—How do you know what to choose?

Researcher: Ja, that was a big thing that came up is that there is nothing standardised or that there are too many options and people get confused and...

Mr Jones: Ja... that's right and then people say: "Ag, you know I'm not going to make a huge killing on this and lets just wait until the prices are nice and low and the good technologies are already established- I'll wait, you know. And one day I'll get there" and that's for solar water heating... PV is maybe a bit simpler in than that- maybe the differences are still important but probably less obvious you know- it looks like a flat plate. Um, I certainly think that the role that municipalities can play is one of education and the city is trying to do that through their accreditation programme for Solar Water heaters, suppliers and has put out quite a nice document just to educate people about... just PV and what you should look for in a supplier and so on. And that I think is an important role- in fact more important than the tariff discussion is just getting people to know the technology and get people to feel that they're confident in the decisions that they are going to make.

Researcher: So what we did in the focus group is we started off giving them 2 surveys to fill in (I just brought copies in case you were interested in seeing what they were about) um, so they filled in these two, first, before we told them anything, um, and then we did a presentation about what the technology is, how it works and what you would need to consider, the prices etc. Everything you'd need to know, sort of,

about PV, and then we introduced the tariff discussion once they understood where in the grander scheme of things it would fit in. We talked about the Pros and Cons about PV and what would motivate you to do it and all of that, um, and then we got them to fill in... oh, no then we had a discussion half way through and we facilitated the discussion where they could say what they liked about it and what they didn't like about it [the tariff]. These were the talking points- we didn't stick to it exactly but covered most of the content was covered and then we gave them a second survey in the end, which is basically to see if the information changed what they initially thought. And Very interestingly, ignorance seems to be bliss because at the beginning everyone was like "yes, we like this thing, it sounds so great," but then once we told them all about it, they were like: "ooh, actually, no, its not really for me." So what was interesting to see was that information is important but HOW you package it and what you choose to tell them and how its structured needs to be really carefully considered and possibly the way to do that is look at condensing the information out there (people seemed to want three or four options they could choose from) it would be so much easier-based on the different needs they could decide which model they would choose if they wanted to save money, sell back, be green... whatever... and then there would be a package for each type of option. So I just thought maybe you'd be interested to know a bit more about that and...

Mr Jones: Ja well that's my gut feeling is that um, when you know that you don't know, you become cautious, but when you don't know that you don't know, you... off you go! But when you know... doesn't mean you stop.. it just means that you're cautious so maybe the time that you took that second survey, um... was half way through that process and people have got to assimilate that, and think about it and check it

and so on- it would be interesting to redo it a couple of months later, with the same people to see how things have changed now. Then they were probably feeling overwhelmed and sort of hunkering down...

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Researcher: Well actually, to minimise that whole effect, we took people who were already familiar with PV systems (actually they self selected that way where people who already had an interest showed up and those who don't, didn't. This is in itself interesting). It wouldn't have been completely overwhelming in terms of the amount of information because they knew the technology- some of them even had their own systems already- um, you know the thing they complained about most was the monthly R140 connection fee to the grid. They would spend up to R180 000 on a system with batteries but they don't want to spend R140 a month to attach their PV systems to the grid to earn with the feed in tariff.

Mr Jones: You know, again, just in terms of how our tariffs are structured, um, the energy charged in the first block, if you look here is 102c until you get up to 600 units then it goes up to 200c. Now just remember that 102... if you look at a normal residential domestic, its 164c, alright? But they don't have the daily energy charge... if you too 600 units (the average) and x it by 164, that's exactly the same as 30 days x that daily service charge, plus 600 units plus that 102. If you add those two costs together, you're paying exactly the same as you would as a domestic... up to 600 units. So, um, I mean its designed for 600 units. If you consume less than 600 units you actually end up paying more... than as a residential small scale embedded generation, so the tariffs , there are always winners and losers, um but its designed... perceived that they shouldn't be paying it but for a

average user, they are paying the same as they would've paid. So it's a perception that it's extra.

But you know what we're doing? We are now, because um, energy efficiency is coming to the fore, and we still have to keep the network going, we for our SSEG we've got separate network charge and separate daily service charge alright? Our new residential tariffs we've introduced a voluntary residential tariff which works exactly the same way: it's got a daily service charge and it's got an energy charge and the idea is that one day all residential people (and they used to have this in the past but there were reasons why we moved away from it) residential consumers and SSEG consumers will be exactly the same, and they will all be charged a daily service charge. They will all be as unhappy as each other. So we are heading towards that and we need to say cost reflective tariffs where you pay separately for the grid and then you pay separately for the energy, so those tariffs are here, they've already been... They aren't exactly the same but because they're going to ... they know what the cost of supply is, but they don't want to... give people too big a leap in one year... But in the future, SSEG and residential consumers will all be on the same tariff instead of something different... So that argument is going to fall away and that's an important thing to recognise that's happening. The reason that in the past we didn't do that was if you got the prepayment meter and the prepayment meter is recovering that daily service charge and the cost for energy, how much you get for your rand, per rand, depends on how many days since you last purchased. Because you pay for days lapsed x the daily service charge + the amount of energy you want so I mean, people can understand their cell phone bills hey... but they just don't want to understand their electricity.

Researcher: So is this why its cheaper to buy electricity at the beginning of the month than if you buy in the last week of the month?

Mr Jones: Yes, well that's the way it used to be- I don't know where you live but-

Researcher: Simons Town...

Mr Jones: It used to be like that- now it should...no... now the difference for you... in the past we used to have it like that and that's the reason. What happens now is that because of the new block- domestic, up to 600 units at 154c per unit and over 600 units you're paying it at 187c so if you bought at the beginning of the month, and you bought 600 units and it ran out in the third week and it ran out then you go and buy again... then you're going to be paying at the higher rate. So that's probably what you're experiencing...

Researcher: Well I live alone so there is no ways I am using more than 600 units

Mr Jones: You have to be, I cant see how you're not- there is no other way you'd be paying more otherwise...Discussion about my bill goes on a bit longer- irrelevant...

Researcher: The last section I'd like to talk about: um...I'm concerned about households that cannot afford to buy their own solar PV systems going forward. What is the plan for them ... because I have spoken to a number of PV retailers and their perception is that very low income households are the government's problem in terms of how they get their electricity and the PV retailers tend to target the upper income households but then the middle-to upper income household is not considered as part of this target market. So there is almost a gap where there is interest and potential... for example my mom is

interested in solar PV and she has some money that she could invest in a solar PV system but why should she make PV the investment she chooses to make. So I was wondering if there were any plans to try and open that part of the market going forward...?

Mr Jones: I think it will naturally open itself as the Eskom price goes up and up and up... and up and up and up.... and if its not happening now its going to happen in a couple of years time.

Researcher: Ok but now we're stuck in a place where we are hoping that PV will... the market will explode and the prices will come down, making it more affordable to people and when the price of Eskom goes up, people will now be able to buy PV, but this focus group and the research done by the energy game changer done to find out how many of these upper income households are actually going to buy (again you can't predict behaviour) but it doesn't look like there is going to be that "explosion" yet. What are we doing about that?

Mr Jones: Well when you say "what are we doing about that" you know there is also a very practical aspect of this is the capacity of the municipality to handle applications and problems which arise out of increasing PV, um and if I'm honest, I think that I don't want to see this promoted beyond the capacity of the municipality – there is a learning curve all round here. So I think there is a kind of natural progression which is great, I think that, um, last year I went to a good seminar on rooftop PV and I looked at other country's experiences and after grid parity was reached (in other words in one way or another- where there was a subsidy there or a feed in tariff, but when it started making financial sense to employ PV) it looked like (among a couple of the countries that they mentioned that there was a 5 year period where you went from nothing to having problems managing

your grid- this incredibly fast take up- I can't remember if they were developing countries or equivalent or just first world countries but it looked like there was going to be a natural progression driven by everything- the fact that you see your neighbours and everyone has got one now you have to have one as well... and when prices rise and then PV becomes normal... and it looks like a natural progression, you really you can put a lot of effort into it but its going to happen by itself with this incredible momentum is just going to pick up and I think that that's going to happen here...

The only thing, which is going to slow it down, is our exchange rate- that's the thing.

Researcher: So one of the things that will help is having local businesses and manufacturers...

Mr Jones: Ja but it's the core stuff you know, its not the brackets or anything – that's all already made locally... it's the actual material which converts...and you know that's now made by China and who is going to beat China...? In terms of price. But then we are still tied to the exchange rate... so I don't know... perhaps somebody's looked at that- there have been companies- mainly its assembly... but all the high tech production plants... I think we missed that boat- it sailed a long time ago.

Researcher: [laughs] why did we miss it...?

Mr Jones: Because we've got our heads in the sand...

Researcher: So with something like that- planning would've been required...

Mr Jones: Ja... ja... but let me ask YOU a question: Why is it such a big deal that everybody has PV on their roof? I mean compared to... I'm still neutral here, you know people are wanting to do it and we have to accommodate it... but isn't it maybe better to have a big... a couple of large scale solar-wind farms in the uh... dotted around the country where there is less cloud? Um...

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[Pause]

Researcher: THANK YOU for asking that question! When I asked you earlier "why PV" – that's is actually what I meant- Why, in this way... why PV? From what I have found from asking people all of these questions is that. Well that 's why I asked you about the drivers..

Mr Jones: OK, lets just tick off all the drivers as we go... you have the Greenies- they think that they are going to avert global warming, look its right to do the right thing...

Researcher: But as a Greenie you could also invest in something different...

Mr Jones: And I don't mean to be... when I talk about "Greenies" I'm talking about people who ... I mean they are absolutely sincere about trying to stave off global warming, you know it's a serious thing, but there has to be a balance you know? You can stave off global warming and then have a social breakdown because... for other reasons... so Greenies... ja. There are also people who genuinely want to reduce their costs in the long term and I think that's going to come more and more to the front as Eskom's price goes up and up and up and as exchange rate goes down and as fuel price goes up and a escalation

goes up (probably meant inflation?) then people are going to feel more of a financial pinch. But whether, again, are you really going to save all that much money? As a middle income household and electricity consumer- the potential to save is only so much you know? Um, maybe in 20 years time when you are saving and when the cost of electricity is high and then you can see that jeez that investment was a fantastic idea- it probably will work out like that but people don't see that right now. They are just looking at "today" and what it costs.

Researcher: Yes, I think its that short term perspective and but also if you ask "why PV" as opposed to Green electricity or something else- its because you can see the saving and you have the panels on your roof and you can physically do something and have control over your electricity system- so in terms of this need for control and to realise the benefits, that's probably why PV but... when I began this project, I was interested in District Energy systems and wanted to plan something great that caters to a need, specifically in Stellenbosch because there are all sorts of plan to design the future development of the town etc. but I think that a lot of organisations and a lot of people have just decided that PV is the answer and now they are trying to drive it and push it through without looking at whether it is what is needed. So my question throughout this whole investigation is exactly that: why PV in this way? But its difficult for me to find people who want to have that discussion-

Mr Jones: Ja. Can I tell you why? Because there is lots of donor funding which is feeding a lot of NGOs and a lot of Para government organisations and they're producing reports and studies...

Researcher: Hmmm they gave me my bursary as well...

Mr Jones: Ja and that's the point, you know, is that there are a lot of invested interests... we all have invested interests- I'm employed for green energy- I suppose that's a vested interest you know? Um, certainly we have to reduce global warming... I mean maybe it will be better to have a large scale wind farm that people can invest in... you know? And then you get dividends... you know? And there are better ways of doing it.

Researcher: And again you've got to move away from the, I suppose the more reactionary to the more long term planning approach and I suppose that that means that direction needs to come from national government.

Mr Jones: Ja absolutely. It would be great if they could sell shares then it enables local ownership- I mean I don't know if they will agree with is but you know with this big solar park they want to put up in the Northern Cape- give people- the man in the street- the opportunity to buy in and it can be professionally managed... and you don't have to worry about batteries or you house burning down... ja.

Researcher: Well that's why I thought that even if you don't do it as far away as, now I am just thumb sucking here, but if you have... like if you think of a town like Stellenbosch- if you think of what is around it that you can use and get residents to invest in something like that so that you can put it in... But when I wanted to raise this with the municipality, they were just like "we don't have money, we don't have money..." and I said to them "but there are other ways" but they were not interested in talking about it.

Mr Jones: Green Cape might be... uhhh, you need to find a juristic person who

can raise loans and enter into contracts with people... but the trouble is that that company now has to sell that energy to someone... and now this is the key... that company who is running that wind plant or that PV plant has to have an off-taker for that energy, now, um, at the moment that is done through the REIPPP programme and they've got their own investors- investors haven't been... in the programme there is a focus on community development in the area but nobody is like publicly listed and sold shares to make that available and there is an opportunity there but that's done on the bid basis... so...

Researcher: Ja but that is for very very large scale energy projects, isn't it? Like if there is something smaller...

Mr Jones: Ja, ja but the KEY is that they still have to sell that energy to a long term off-taker to get their income and give the dividends to their shareholders now, how do you sell that energy? How do you? The municipality- we want to buy energy from (and that's a brilliant idea in the future) that we must specify who must invest and they must do it in this particular way... but um, we've written to the department of energy... and the department of energy and the government's um policy is that Eskom will be the sole purchaser of electricity from an IPP. Right? Policy: Eskom will be the purchaser... and there is good reason behind that because what happens if Cape Town- you know has got lots of wind- and we invest and we generate and in 10 years time our electricity tariff is 50% less than in the rest of the country...alright and we're not buying from Eskom so Eskom now have to raise the tariffs for everyone else and Cape Town, just because they are lucky and they have got lots of wind, um, are going to really score. Now you know how well that is going to go down politically? And the fairness of it... and you have to start looking at cross subsidies and and and... so there is a good kind of reason to

say: lets centralise it, instead of letting municipality go off and do their own thing. The mechanism again, would be to specify that um, that, lets just say that these large wind farms must first offer 10% of their capital must be made available to small householders... or something... and this would be an interesting thing to pursue...

Researcher: But then would people want to be investing and then still buying electricity?

Mr Jones: Well then they are still also receiving dividends so financially it should still all work out... they should win. Ja, its actually an interesting idea and its been done elsewhere around the world where municipalities have got more freedom to create that sort of situation and financing mechanism.

Researcher: So what would be needed to actually get something like that to work here?

Mr Jones: Again, the big issue is that anybody who wants to sell energy must be assured that they can sell it to somebody and that's the way at the moment. And the only way to do that at the moment is through the REIPPPP and at large scale and you've got to sink millions- you've got to be sure about your investments and now you don't know if... you know... I don't know... you'd maybe have to discuss with the development bank and see if they will finance short term with a view to... or they will provide that portion of finance and they will... come up with some financial scheme... but the key is you need an entity which has got a power purchase agreement with an off taker.

Researcher: Ok, going back to what we said earlier about Cape Town developing its own energy system based on its natural resources, on the one hand

it will be a bit unfair... but on the other hand, will it not motivate other people to look at their options?

Mr Jones: Ja but in a way we have to supply the energy because one day the sun isn't shining and the wind isn't blowing and then what? We still have to supply the energy...

Researcher: Ja, but you can design the system to cope with intermittency...

Mr Jones: Ja but after a couple of days with no wind the lights go down and the motor starts slowing down... there still has to be someone, somewhere who provides for that and it has to be funded. You know, just at the moment, the way our whole regulatory system is set up- it doesn't lend itself to...

Researcher: Short term change like that...

Mr Jones: Ja, ja we are kind of locked into a system- I don't know- I'm not a regulatory system specialist... you know the thing is: if you deregulate... I don't think I...our regulation system doesn't work as well as we would like... Now the regulator doesn't sign off on tariffs and we implement them anyway, now if you've got it deregulated (I mean it's a free open market thing) its still got to be regulated and you need a regulator who can really regulate- who's got big teeth and he can make sure... the regulator at the moment can't tie his shoelaces. So if we deregulate it then you know? Then everyone is in it for the short term profit and they don't invest in the system and then the grid collapses and so you need... you have to think quite carefully... so maybe what we've got is the best but it needs more bight lights in the department of energy for our particular circumstances on the generation side at least. Not easy to solve.

[Pause]

Researcher: Ok, another question: do you know anything about why Drakenstein hasn't managed to (so they have also implemented their feed in tariff and its quite a good one – its almost one to one) but why they haven't managed to improve the uptake of PV- people haven't really bought into the uptake of PV

Mr Jones: I don't know. Again um, the little excess you're making, you're not going to make much of a profit on the money you're putting back into the grid. Your big thing is offsetting your consumption. If you're paying R1 for excess consumption but saying R2 on decreasing the amount of electricity you're purchasing it obviously makes more sense to saving rather than putting back...

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Researcher: Just going back to the question of why PV in this way- How much PV feed in is actually required to make a significant difference in terms of being green etc.?

Mr Jones: I don't know exactly- but a lot. And already there are restrictions- technical restrictions in terms of how much electricity can be fed back into the grid- because the grid is designed to handle a certain level of generation- you know- on Sunday when everybody is sleeping and its summer and you've got this huge amount of energy coming back at you and you don't know what to do with it you know, so that's uh...

Researcher: So it's a bit more of a perception than an actual help...

Mr Jones: Ja, ja. Where is does make sense is um, for corporates who are busy during the day. But let me just show you the power point graphs ... (retrieves presentation from his computer)... that is consumption and that is reverse power feed back and you can see that there is not much reverse power feedback in commercial settings except on weekends because during the week their consumption is generally far higher than they could ever generate if they covered most of their roofs but on average you'll never generate from your own roof everything that you need but on the weekend when you've gone home all that power comes back onto that grid. Residential is completely different – you can see there they feed in (because people are only consuming at night time) there is no sort of weekend pattern and they feeding in a lot more back during the day. So all that stuff below the line there is all that stuff that we have to deal with so now if you don't have batteries to absorb that ...if you can store it you can use it during peak periods and just keep it in the battery. I did a battery storage tour around the USA looking at batteries- this is excess generation and the difference is that issue is purely the difference between summer and winter- look at the difference. Ja. So. The realities of PV and Feed in.

Researcher: So we can say then that PV could be useful to save money at the right price and then the feed in is limited by the grid anyway but storage is the key in that argument.

Mr Jones: Ja cheap storage is the key and then you don't even have to put it in the grid. It just seems to me that this could be a great solution- there are so many benefits that it can be used for. But that's going to be the future- a whole different discussion in itself- [laughs] sorry I hope I haven't drilled holes in your thesis now..

Researcher: [laughs] No, you haven't, those holes have been there and I have tried

to plug them but actually I can't. and that will be an important part of my findings- the PV mission is great but its not going to do what you hope it would do.

End of interview.

Appendix D: Meeting notes from Interview with Mr Jan Coetzee

Meeting Topic: The Municipality's perspective

Date: 19 May 20 15, 9am-10am

Participants: Me, Mr Jan Coetzee

Venue: Mnr. Coetzee's office at the Municipality building, Andringa Street.

Notes:

I got the feeling that Mr Coetzee didn't really want to speak to me or that he was on his guard because he thought I was there to attack him/ his work?

I explained who I was and that I was adding a social perspective to Nikki's work and would be conducting a survey to gain some insight into public opinion and willingness to invest in PV systems.

This was the set of interview questions I used with answers underneath. I did not take notes for all of them as some questions I decided to skip during the interview. This interview was unfortunately not recorded electronically. I took notes when necessary, as Mr Coetzee spoke.

1. What is your role in this department?

- Responsible for the maintenance and running of the local grid network and policy that governs how it is used.
- Responsible for working with consultants to draft the master plan for the development (upgrade) of this network to keep up with town development.

- Works with the finance department to develop budgets for maintenance and development work

2. How does your work contribute to the overall supply of electricity to Stellenbosch town?

Explained above

3. Where are the opportunities for future growth in the Stellenbosch electricity system (short term? long term?)

- He spoke about the expanding town in response to an increasing population of students and working people as businesses have started moving their offices to the town.
- He did not like me mentioning the IIC- he stiffened when it came up and gave curt answers- I made a note I had only seen him at IIC meetings once.

4. What are challenges do you face on a daily basis?

I decided to leave this question out- seemed out of context at the time.

5. What are the broader challenges that face electricity supply in Stellenbosch?

- He really wanted to answer this question. He mentioned pressure that the Municipality is facing from all sides: Pressure from the CRSES to get a FiT for residential scale solar PV, pressure from the political players (no names mentioned) in the municipality who are worried about revenue loss and its potential effects on the grid maintenance budgets. He also spoke about all

other services (water, sanitation and refuse removal) that are subsidised from the revenue generated from the sale of electricity, pressures from Eskom where electricity shortages and load shedding occur, pressures from the developers who want the grid extended to their new building projects, the concern that if those who demand the most electricity and pay the highest bills start to reduce their electricity bills via solar PV or energy efficiency (EE) installations, there will again be less income to subsidise the electricity to the poorer communities.

- There are also technical challenges posed by the current condition that the grid is in at the moment- there are maintenance backlogs and upgrades of transformers and cables will need to be done soon. He went into great technical detail here- some of it I understood, some of it went straight over my head but he liked talking about it- and I realised that being asked to speak about social issues was strange for him. Perhaps he felt a bit out of his depth- he understood the technical jargon- all of it- in great detail and that's what he could explain. I listened.
- The Municipality OWNS the local electricity network in Stellenbosch as they built it- that is why the CRSES needs to apply to them for a Feed in Tariff. There is no law that states that a municipality cannot buy electricity from a third party (ie. not Eskom). The Municipality buys electricity from Eskom that is transported from the Eskom generators through high voltage lines and there are power losses along the way.

6. Do you think that renewable and/ or alternative energy sources could assist in managing some of these challenges? Why/ why not?

- He thought that they could- but that they also present their own set of challenges. While PV could help with meeting electricity demand and mitigating against energy losses, the grid can only handle a certain amount of electricity being fed back and will need serious upgrades if it is to accommodate more electricity feed in from households than what it can currently handle. There is also the issue of regulation- new regulations for PV will need to be drawn up to regulate the quality of the inverters etc installed by people if they want to feed in as well as ways to implement these regulations. Green Cape is apparently planning to help them develop these regulations as well as a tariff to ensure there are no losses in revenue from illegal grid connections (when people leave their meters to run backwards. This is happening already and is likely to continue if the Municipality does not step in and regulate it.)
- Issues of intermittency and the fact that most of the electricity will be fed in during the middle of the day when the sun is strongest and no one is at home to use it (assuming it is not stored) also need to be considered.

7. Are there any plans to incorporate or encourage the uptake of any renewable/ alternative energy systems/ sources? Why/why not? If so, where can these be found?

- I did ask if the Municipality had any plans to incorporate some renewable energy projects to decrease municipal electricity demand or if the municipality would consider becoming small-scale energy generators themselves in the future- but he just laughed and said the Municipality does not have that kind of money.

- He says he is aware of the CRSES agenda to push for a FiT. He says that when he first started doing this work- no one had even heard of renewable energy so they never planned for it. Now the discussion has gained momentum rapidly and they are being forced to consider the implementation of a feed in tariff (NOTE: not to look into other RE options- almost have tunnel vision regarding this PV solution.) because they have so many challenges- at this stage it looks like they'll take the solution where others can tell them exactly what they need to do-as he doesn't seem to believe he has the time to participate in discussions with other players in the system transdisciplinary TD style.

(As noted earlier- this social stuff is not part of the his job description. Possibly I am speaking to the “wrong” person/ Municipality representative here- if I want to talk about development plans- just shows how departments don't speak to each other/have coherent, joint aims/ projects.)

8. What do you think of encouraging the uptake of solar PV technology on a residential scale? Challenges/ opportunities?

Pretty much already discussed above

9. What sort of research would you find useful to implement the long term/ short term plans – any potential RE plans

- Nikki's finance research. He also would like to have an idea of how popular this FiT will make PV- how many people are likely to change

their minds and invest once a FiT is allowed. He would also like to know if people are more interested in installing PV with batteries and if they are interested in going off grid. This prospect worries him as if everyone went off grid- there would be the risk of “grid death”- there would be no revenue from the sale of electricity and therefore no money to run and maintain the grid and so there would be no electricity supplied to poorer communities. (This is perhaps an exaggeration because of how expensive batteries are and the fact that this could happen regardless of whether a Feed in Tariff is put in place).

10. Explain research idea: would this help? How could it be improved?

- This is not his area of expertise but basically I need to include a question of whether or not people will want to install batteries.

Reflection:

Key points from this interview:

1. Municipality is under lots of pressure from all sides and not sure what to do
2. Going with CRSES and Green Cape and embedded PV because they seem to be offering concrete advice/ are presenting a stronger argument than the IIC (too radical? Lack of interest in discussion from the electrical department? Lack of trust in motives behind IIC? Stronger connections to the CRSES?) – Question effectiveness of “transdisciplinary stuff”? or just barriers towards a transdisciplinary approach?
3. Municipality afraid of revenue loss and potential grid death.

4. Seem to be heading towards FiT in order to reduce revenue loss from illegal connections and to discourage people who can afford to do so from going off grid completely.
5. Want to know what people think
6. Obsessed over knowing whether people want batteries.