Perceptions of factors affecting growth in the Small-Scale Embedded Solar Photovoltaic sector in South Africa

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ABSTRACT

South Africa is experiencing electricity shortages due to the various challenges faced by Eskom. This has resulted in Eskom implementing rotational power cuts, commonly known as ‘load shedding’. Small-scale embedded solar photovoltaic systems are ideal in offering immediate solutions to address the current power shortages and to ensure the country’s security of electricity supply. The study utilised the socio-technical transition framework to investigate the perceptions of factors affecting growth in the small-scale embedded solar PV sector in South Africa.

The study utilised a qualitative research approach. A total of thirteen (13) interviews were conducted, using a semi-structured interview guide. Purposive sampling, which is sometimes called selective sampling, was utilised for this study. The respondents for this study consisted of stakeholders with significant knowledge, expertise, and interest in the energy industry which included policy, regulation, commercial banks, utilities, financial, energy experts, as well as energy journalists and energy analysts.

The findings indicate that socio-technical factors which include institutional, technical, economic, and social factors affect growth of the small-scale embedded solar PV sector in South Africa both positively and negatively. The findings identified the key challenges facing the sector to include lack of funding, regulatory burden, unattractive feed-in tariffs and lack of a clear regulatory framework.

The key recommendations of this study include the development of active strategy from government and the regulator to promote the small-scale embedded solar PV sector, the need for shortening or streamlining of the regulatory processes to facilitate establishment of more small scale embedded generations in the country, introduction incentives such as feed-in tariffs and tax incentives, as well as increasing the threshold of small scale embedded generators of more than 1MW to only register and not need a generation licence.

The findings confirm that socio-technical factors of institutional, technical, economic, and social factors affect growth of the sector. The growth of the sector is critical and is urgently required to address the electricity supply challenges in South Africa.

Keywords: Embedded generation; Factors affecting growth; Perceptions; Small-scale; Embedded; Generation; Solar Photovoltaic

DECLARATION

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

Name: Meddas Charles Hlebela Signature:

Signed at: **North Riding**

On the: **18th day of October 2021**

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INDC:	Intended Nationally Determined Contribution
IRP:	Integrated Resource Plan
JET:	Just energy transition
MW:	Megawatt
PV:	Photovoltaic
SADC:	Southern African Development Community
SHS:	Solar Home Systems
SSEG:	Small scale embedded generation
SSE S PV:	Small-scale embedded solar photovoltaic

CHAPTER 1: OVERVIEW OF THE STUDY

1.1 INTRODUCTION

The electricity industry is undergoing rapid changes globally (Boulle, 2019; Chawla & Pollitt, 2013; Pollitt, 2012). The notable changes include the unbundling of vertically integrated utilities, a move from fossil fuel technologies to renewable technologies as well as the need for countries to reduce greenhouse emissions as per the Paris commitments. The electricity industry in South Africa is also undergoing similar changes.

According to Knight and Mahlalela (2019), conventional electricity systems have long been associated with vertically integrated state monopoly entities with large-scale and dispatchable generators. The conventional electricity system is evolving through the unbundling of the utility's integrated business into separate businesses (Pérez Arriaga et al., 2017). Eskom, South Africa’s vertically integrated utility is undergoing unbundling of its business into generation, transmission and distribution. The unbundling is enabling participation of renewable energy technologies in South Africa’s electricity generation sector. Martinot (2016) contends that unbundling has enabled private participation and competition through the integration of variable renewable generators, such as rooftop photovoltaic (PV) at the distribution level. Filipova and Morris (2018) view small-scale embedded generation (SSEG) as part of the evolving trend to decentralise vertically integrated electricity systems.

Pérez Arriaga et al. (2017) posit that the emergence of innovative technologies and reducing costs is making renewable energy technologies more economically viable than conventional fossil fuel sources. According to Terrapon-Pfaff et al. (2014), innovative renewable technologies are more suitable for small-scale embedded generations (SSEGs) and distributed energy provision. SSEGs can provide reliable electricity in South Africa given the current supply challenges experienced by Eskom. Knight and Mahlalela (2019) maintain that the aggregation of small-scale generators, such as solar PV, plays an important role in providing a reliable supply of electricity. Distributed technologies, such as energy battery storage and innovative energy electronics are providing alternatives for the supply and utilisation of electricity (Pérez Arriaga et al., 2017).

The need for countries to comply with the Paris commitments, which seeks to reduce the global emission of greenhouse gases (GHGs) to between 1.5 ^{0}C and 2.0 ^{0}C (Tribett et al., 2017), is further compelling countries globally to reduce greenhouse gas emissions (Kern & Rogge, 2016). All countries that have signed the commitment submit a list of Intended Nationally Determined Contributions (INDCs) that indicates a strong commitment (unconditional INDCs) or a strategy which is subject to financial or technological support (conditional INDCs) to these reductions (Tribett et al., 2017). According to Boersma and VanDeveer (2016), a total of 195 countries committed to the Paris agreement. South Africa is a signatory of the Paris agreement. Critical to reducing greenhouse emissions is a just energy transition (JET) trajectory. Altenburg et al. (2010) contend that JET needs a new technological paradigm. This view is supported by Morey et al. (2011), by emphasising the importance of new technologies in addressing the impact of climate change. Important choices in JET consist of various kinds of social, political and economic formations established in conjunction with new innovative power technologies (Miller et al., 2013). Hirsch, Mattheß and Fünfgelt (2017) emphasised the importance of broadening the scope of a JET reference framework to include three dimensions which are: climate, socio-economic and political. Important to South Africa's JET trajectory is consideration of the triple challenge of poverty, unemployment and inequality.

According to Rothfuß and Boamah (2020), decentralised electricity generation systems have the potential to leapfrog countries in the global south into electricity systems of the future. However, literature indicates that factors such as a lack of a regulatory framework and uncertainty in government policies and regulations are amongst the obstacles to the introduction of renewables (Nasirov et al., 2015; Yaqoot et al., 2016).

1.2 RESEARCH PROBLEM

According to Ratshomo and Nembahe (2018), Eskom dominates the generation, transmission and electricity distribution sectors. The Eskom Integrated Report (2019) states that the utility generates 90% of the country's electricity. Eskom is experiencing electricity capacity constraints. This is due to a depleted electricity reserve margin which started in 2008 and resulted in Eskom implementing rolling black-outs throughout the country (Joffe, 2012; Monyei & Adewumi, 2017). This culminated in the implementation of stage 6 load shedding for the first time in the history of the country on 9 December 2019. According to Eskom's statement issued on 9 December 2019, Stage 6 entails taking off 6000 MW of power to be rotationally load shed.

Given Eskom's challenges indicated above, small-scale embedded solar photovoltaic (SSE S PV) system is ideal in offering immediate solutions to address the current power shortages and to ensure the country's security of electricity supply. Bischof-Niemz (2019) argues that opening the market for SSEG to feed energy into the Eskom and the municipal grid is the quickest and easiest way to bolster energy supply shortages. He further contends that the liberalisation of SSEG would result in many projects, mostly solar PV, that could be implemented within months thereby addressing the current capacity shortages. However, for the SSE S PV to be effectively integrated into the electricity value chain, Bischof-Niemz (2019) suggests the need for a conducive regulatory framework environment to send the correct market signals that will incentivise grid integration and disincentivise load shifting and grid defection.

Anecdotal evidence indicates that current regulatory framework is perceived not to be clear in terms of facilitating the growth of the SSE S PV sector. According to Baker and Phillips (2019), there is no clear regulation for feeding electricity back into the grid from SSEGs in South Africa. The lack of regulatory framework and uncertain government policies are amongst the obstacles to the adoption of renewables, and there exists a positive relationship between policy proclamation and growth of projects in the renewable energy sector (Painuly, 2001; Zhao et al., 2011).

The problem is the lack of growth in the SSE S PV sector despite the current challenges of load shedding, unreliable electricity supply and increasing electricity prices. Also, the problem is a lack of growth of the sector even though South Africa's radiation is ideal for solar PV electricity (Mulaudzi & Bull, 2016). Furthermore, the costs of solar PV technologies are decreasing rapidly as well as costs of energy battery storage to mitigate the intermittency of solar PV electricity (Ram et al., 2018). Also, anecdotal evidence attributes the lack of growth to the absence of clear government policies and regulatory frameworks for embedded renewable energy generation technologies, including SSE S PV. However, these are perceptions of some stakeholders in the electricity sector. In this regard, the study investigates the perceptions of factors affecting growth in the SSE S PV sector from an holistic perspective, looking at a variety of socio-technical factors. The study also sheds light on how these factors could assist to enable growth in the SSE S PV sector.

1.3 PURPOSE OF THE STUDY

The purpose of this qualitative study is to investigate the perceptions of factors affecting growth in the small-scale embedded solar photovoltaic (SSE S PV) sector in South Africa. The study also aimed to identify and describe the perceptions of factors that are barriers and key drivers for the growth in the sector.

1.4 RESEARCH OBJECTIVES

There are two research objectives of this study:

- the first objective is to identify and describe the perceptions of factors that are barriers affecting growth in the SSE S PV sector in South Africa; and
- the second objective is to identify and describe the perceptions of factors that are key drivers for growth in the SSE S PV sector in South Africa.

1.5 RESEARCH QUESTIONS

The two key research questions of this study are:

- What barriers are affecting growth in the SSE S PV sector in South Africa?
- What are the key drivers for growth in the SSE S PV sector in South Africa?

1.6 CONTEXT OF THE STUDY

South Africa is currently experiencing electricity shortages due to the various challenges faced by Eskom (Analytica, n.d.; Bowman, 2020; Joffe, 2012). These challenges include the consistent breakdown of old power stations and delayed completion of new power stations such as Kusile and Medupi (Bohlmann et al., 2016; Pollet et al., 2015). This has resulted in capacity constraints that necessitated Eskom to implement rotational power cuts, commonly known as ‘load shedding’ in 2008 and 2018 (Knight & Mahlalela, 2019). Load shedding is causing a significant setback to South Africa’s economic growth prospects (Lenoke, 2017), this has resulted in the downgrading of the country by international rating agencies (Mutize, 2019). On 18 December 2019, Fitch Ratings’ media statement indicated South Africa’s negative outlook rating to be a reflection of the government's deterioration of a fiscal situation that reflected additional expenditure (0.5% of GDP) to support Eskom (MoneyMarket, 2019). Energy is important for South Africa's economic development. Knight and Mahlalela (2019) contend that energy security of supply is a requirement for economic development. Renewable energy technologies such as SSE S PV are important in ensuring security of supply. Renewable energy technologies can enable countries to increase electricity access and provision of reliable, secure, and affordable electricity (Knight & Mahlalela, 2019). They further observed that developed countries that are leading with regards to SSEG uptake have enabling policies in place despite having less sunshine than the Southern African Development Community (SADC) countries. The enabling policies include feed-in tariffs. As indicated by Miller et al.(2014), other countries are ahead with the uptake of solar PV due to massive subsidies through attractive feed-in tariffs.

South Africa is well endowed with solar radiation that is ideal for solar PV generated electricity. The Department of Mineral Resources and Energy (DMRE) estimates the annual solar radiation for South Africa to be 220 W/m2. The DMRE further maintains that this makes the country's resource one of the highest globally. SSE S PV is ideal to provide electricity to complement current shortages experienced by Eskom. The power supply constraints, decrease in the price of solar PV systems and escalating electricity prices have resulted in increased interest in SSEG in South Africa (DoE, 2015; Knight & Mahlalela, 2019). According to the comparative analysis conducted by Bischof-Niemz (2016), the average tariff for coal IPP was 1.03 R/kWh compared to solar PV at 0.62 R/kWh in April 2016. The advent of energy battery storage is making this technology affordable, accessible and mitigates the intermittency of solar PV technology.

There are various factors that can impact a rooftop PV programme. These include the potential of the solar resource in a specific area, the system's technical potential and the economics of the programme, which is reliant on the regulations and policies in place (Knight & Mahlalela, 2019). However, regulation and regulatory frameworks are critical for the introduction of SSEG into the electricity value chain (Nelson, 2017; Painuly, 2001; Zhao et al., 2011). In this regard, an holistic approach, that takes into consideration all socio-technical factors such as technical, economic, financial and institutional is critical for the successful adoption of energy technologies (Sovacool et al., 2011; Sovacool & Drupady, 2011). Given this context, this study investigates the perceptions of factors affecting growth in the SSE S PV sector in South Africa.

1.7 SIGNIFICANCE OF THE STUDY

The SSE S PV sector is at an early stage in South Africa. There are few academic studies conducted on socio-technical factors affecting growth in the SSE S PV sector in South Africa. Research conducted relates to the contribution of SSEGs to the establishment of Small Medium and Micro-Enterprises (Mkhwebane & Ntuli, 2019), the impact of SSEGs on municipal revenues (Korsten et al., 2017) and the politics of electricity transitions (Baker & Phillips, 2019).

1.7.1 Academic significance

The academic significance of this study is that:

- findings will contribute to the academic literature in the energy policy and regulatory body of work;
- the study will assist in identifying new factors or constructs that can be quantitatively investigated by further research;
- the study will also assist in developing a model that can be tested quantitatively in the future by further research; and
- the study will assist in extending the explanatory power of the grounding theory in the energy sector.

1.7.2 Managerial and policy significance

The managerial and policy significance of the study are as follows:

- the study will assist energy policymakers and regulators to gain a deeper appreciation of challenges or obstacles facing the SSE S PV sector;
- the study will further assist policymakers and regulators to formulate policies and regulations that will enable investment and growth of the SSE S PV sector in South Africa, which may, in turn, assist in resolving the power crisis being faced by the country as well as by other developing countries;
- this research will assist in finding an optimal path as the rapid expansion of the SSE S PV sector could create an environment where conventional power stations become stranded assets and the society having misallocated capital;

- the findings will benefit the economy of the country by contributing solutions that will reduce prospects of load shedding; and
- the findings will assist in facilitating the introduction of competition in the electricity generation sector.

1.8 DELIMITATIONS OF THE STUDY

The delimitations of the study include the following:

- the study focused on embedded small scale renewable energy generation only;
- the study only focused on small scale embedded generation of up to 1 MW (nameplate capacity), excluding generation stations above 1MW; and
- the study only focused on one renewable energy technology, which is solar PV, and excludes other renewable technologies such as wind.

1.9 DEFINITION OF TERMS

Centralised generation: PV generators programmed and dispatched by the independent system operator (de Faria et al., 2017).

Distributed generation: PV generators connected directly to the distribution network, mainly used to supply residential and commercial entities (de Faria et al., 2017).

Embedded generation: Small-scale technologies that generate power close to the consumer (IRP, 2019)

Feed-in tariffs: A premium rate for electricity fed back into the electricity grid from a designated renewable electricity generation source like a rooftop solar photovoltaic system or a wind turbine (de Faria et al., 2017).

Growth of SSEG: Development or expansion of SSEG technologies

Perceptions: Insights, views or opinions

Small scale embedded generation: Generation facility of ≤ 1 MW and connected on the customer side of the meter (NERSA, 2018)

Solar Photovoltaic: Electricity generated directly from the conversion of energy from the sun (Sampaio & González, 2017)

1.10 ASSUMPTIONS

The assumptions of the study are the following:

- availability and willingness of participants of the research to be interviewed; and
- research participants provided honest and factual responses to the interview guide questions.

CHAPTER 2: LITERATURE REVIEW

2.1 INTRODUCTION

This chapter gives a brief overview of the electricity industry in South Africa. It also provides a brief description of the embedded renewable energy in the country as well as details South Africa's key role players in the electricity industry and their related functions. The chapter further describes the study's theoretical and conceptual framework. The last sections of this chapter look at institutional factors (regulation and policy framework), technological factors (SSEG technologies), economic and financial factors (tariffs and costs) and social factors.

2.2 OVERVIEW OF THE ELECTRICITY INDUSTRY

Eskom dominates the generation, transmission and distribution sectors of the electricity value chain and is highly reliant on coal-generated electricity. Eskom operates a total of 30 power stations with a total nominal capacity of 44 172MW, and 36 479MW from coal-fired stations (Eskom Integrated Repo*rt*, 2019). The Eskom Integrated Report (2019) further indicates that 80% of the electricity generated by Eskom comes from coal-based technology. According to the *South African Energy Sector Report* (2018), Eskom's customers include industries, mines, commercial sector, agricultural sector, residential areas and municipalities. In this regard, Eskom generates, transmits, and distributes power to these customers.

South Africa will continue to rely on coal-generated electricity as renewable energy is not yet ready to become baseload electricity due to constraints such as development in technology and the optimal design of renewable energy systems (Thopil et al., 2018). However, Baker et al. (2015) argue that South Africa's electricity industry is changing. They attribute the changes to the challenges Eskom is facing, such as financial problems, capacity constraints, increasing electricity prices, and downgrading by credit rating agencies (Baker et al., 2015). According to Baker et al. (2015), these changes also contributed to the introduction of renewable energy through the Renewable Energy Independent Power Producer Programme (REIPPP) co-ordinated by the Independent Power Producer Office (IPP) of the Department of Mineral Resources and Energy (DMRE). Thopil et al. (2018) suggest that the change from coal dependency will assist the country to meet the REIPPP targets.

The country's electricity challenges worked as a catalyst for the acceleration of the REIPPP programme and the emergence of embedded rooftop solar PV (Baker et al., 2015). These changes are also acknowledged by Eskom by indicating the pressure and competition experienced by the traditionally vertically integrated utilities due to the advent of the decentralised electricity industry business model (Eskom Integrated Report, 2019).

2.3 EMBEDDED GENERATION

The *Integrated Resource Plan (IRP)* (2019) describes embedded or distributed generation as small-scale technologies that generate power close to the consumer. Small-scale technologies include solar PV, wind, hydro and biomass (Terrapon-Pfaff et al., 2014). Baker et al. (2015) argue that solar PV embedded generation facilities can be constructed quickly as compared to coal stations. They further affirm that embedded generated electricity is consumed on-site (Baker et al., 2015).

The IRP 2019 indicates an increase in the number of rooftop PVs installed by households, commercial and industrial facilities. This is to supplement electricity from the grid. The increase is also attributed to the advances in technology and the changing electricity landscape (Department of Mineral Resources and Energy, 2019). According to Baker et al. (2015), rooftop solar PV has been emerging due to the unreliability and increasing electricity prices from Eskom. Thopil et al. (2018) maintain that small-scale embedded generation systems provide flexible and reliable electricity supply alternatives to end-users and decrease the impact of increasing prices. Small-scale solar PV is quick to construct and operate (Mkhwebane & Ntuli, 2019).

There is no limit allocation for embedded generation in the IRP 2019 until the year 2022 but is limited to 500MW annually till 2030 (Department of Mineral Resources and Energy, 2019). The *Licensing Exemption and Registration Notice* (2017) indicates that embedded generation projects of not more than 1MW are exempted from holding a licence but they need to register with the National Energy Regulator of South Africa (NERSA).This threshold was increased from 1MW to 100MW by President Ramaphosa’s announcement on 11 June 2021. Following this announcement, generation facilities that are up to 100MW are no longer required to hold a generation licence from NERSA. However, these generation facilities will be required to register with NERSA.

2.4 KEY ROLE PLAYERS IN THE ELECTRICITY SECTOR

The following table indicates role players in the electricity sector in South Africa.

Table 1: Electricity sector role players

ROLE PLAYER	**FUNCTION**
Department of Mineral Resources and Energy (DMRE)	Oversight for the energy industry, including electricity.
National Energy Regulator of South Africa (NERSA)	Issue licences for electricity generation, transmission, distribution, trading and determines electricity tariffs and prices.
National Nuclear Regulator (NNR)	Regulates nuclear power stations and nuclear energy value chain.
Department of Public Enterprises (DPE)	Oversight role over Eskom as government shareholder representative.
National Treasury (NT)	Financial oversight role and provides loans and government guarantees for Eskom.
Department of Water Affairs (DWA)	Provides water infrastructure for the electricity sector.
Department of Environmental Affairs (DEA)	Enforces environmental compliance, prevents pollution and ensures sustainable development.
Department of Trade and Industry	Ensures fair and equitable development of South Africa's economy.
Eskom	Holds monopoly over electricity generation, transmission, and distribution.
Energy Intensive User Group (EIUG)	Represents the interests of large industrial electricity users.
Independent Power Producers (IPP)	Renewable energy IPPs represent the interests of local and international private sector players; they aim to make a profit and maintain a competitive market.
Non-governmental organisations (NGOs)	Represent the interest of communities and consumers
Labour Unions	Retain jobs, workers' rights and increasing their membership.

Source:Morris and Martin (2015); Ratshomo and Nembahe (2018)

2.5 CHALLENGES OF THE ELECTRICITY SUPPLY INDUSTRY

The electricity supply industry in South Africa is facing challenges. Eskom, as the country's utility dominant in the generation, transmission and distribution of electricity is experiencing challenges regarding generation capacity constraints (Joffe, 2012; Morris & Martin, 2015). These challenges are mainly due to the constant breakdown of the old fossil-fuel based power stations. According to Joffe (2012), Eskom's power stations require constant maintenance because they are old and they are being used continuously to generate electricity to address the capacity shortage. The electricity supply constraints have resulted in Eskom implementing rolling blackouts throughout the entire country. Eskom has implemented load shedding since 2007 in order to protect the system from a total blackout (Joffe, 2012). The shortage of electricity supply has resulted in other challenges such as increasing electricity prices, negative impact on the economy as some businesses have had to close down (Goldberg, 2015; Lenoke, 2017). The increasing electricity prices have also resulted in many consumers not able to afford paying their electricity bills and this has led to electricity theft, mainly through illegal connections (Depuru et al., 2011; Smith, 2004). To address these challenges, a number of initiatives which are technology agnostic have been implemented which include the building of new coal fired power stations (Medupi and Kusile) as well as the introduction of renewable energy such as wind and solar in South Africa's energy mix.

The Southern African region is deemed ideal for renewable energy because of its abundant natural resources, such as solar, wind and hydro (SADC, 2016). According to Morris and Martin (2015), South Africa has an abundance of sun and wind and is therefore well positioned to increase the use of renewable energy such as solar and wind (Aliyu et al., 2018). Electricity generated from solar is ideal to provide immediate and sustainable solutions to the current electricity challenges (Mkhwebane & Ntuli, 2019). Distributed solar PV is quick to construct and the costs of the solar PV technology are decreasing (Aliyu et al., 2018). Embedded solar PV can also feed back into the grid the excess electricity thereby assists in addressing the energy security supply challenge. The need to address Eskom's challenges has provided opportunities for emerging technologies and renewable energy as alternative energy sources (Morris & Martin, 2015).

2.6 THEORETICAL FRAMEWORK

The applicable theory utilised in this study is the socio-technical transition theory which is sometimes referred to as the Multi-Level Perspective (MLP) (Geels, 2012). Rolffs et al. (2015) contend that socio-technical transitions theory consists of a mix of various disciplines such as evolutionary economics, history and institutional theory. Geels et al. (2016) assert that MLP is a qualitative framework that combines philosophies or concepts from various fields such as evolutionary economics (niches, regimes), neo-institutional theory (cognitive and normative rules and institutions) and sociology of innovation (social context of innovation process).The MLP approach views socio-technical transitions as it relates to interactions at three levels, which are the niche, regime and landscape (Geels et al., 2017; Rolffs et al., 2015b; Schot & Geels, 2007). The three levels can be described as follows:

2.6.1 Landscape level

The landscape relates to wider contextual developments that impact the socio-technical regime and regime participants have no influence (Geels, 2002; Geels et al., 2017; Romijn et al., 2010). These developments consist of both external shocks such as economic crises and change of political regimes and slow-changing developments such as ideology, geopolitics and demographics (Geels et al., 2017; Rolffs et al., 2015b; Romijn et al., 2010). Rolffs et al. (2015) further posit that the external changes exert pressure on the regime which results in expansion opportunities for the niche technologies.

2.6.2 Regime level

The regime level, also referred to as the meso-level, is where the incumbent regime resides and is comprised of regulative, cognitive and normative institutions (Geels, 2002, 2004). Ockwell and Byrne (2017) maintain that the socio-technical regime's main feature involves alignment and support of various trajectories from different fields such as technology, policy, markets, culture, science, and users. Geels and Schot (2007) posit that transition happens when socio-technical regimes change from one to the other.

2.6.3 Niche level

The niche level is the micro-level where new technological innovations take place. Niche innovations are described as new social or technical inventions that are fundamentally different from the existing socio-technical system and regime but manage to gain traction in specific applications, markets or with the assistance of directed policy support (Geels et al., 2017; Grin et al., 2010). Ockwell and Byrne (2017) contend that renewable energy technologies are referred to as niche technologies because they are not yet well-established as compared to technologies based on fossil fuel. Socio-technical transitions literature is concerned with how the niches are managed to facilitate extensive change which takes place when there is an increase in momentum at the niche innovations together with changes that happen at the landscape level. This creates pressure and destabilises the regime which creates opportunities for niche innovations (Raven, 2005; Schot & Geels, 2008; Turnheim & Geels, 2013). According to Geels (2002), the process of learning and experimentation of the new technologies happens at this level.

Rolffs et al. (2015) argue that the benefits of socio-technical transition theory include its focus on the synergies and connections among the three levels, emphasis on learning and co-evolution and the view of change as a non-linear process. A transition takes place through the concurrent merging of several dimensions and levels (Rolffs et al., 2015). They further emphasise the importance of networks of actors that are aligned to the same rules within the niches and regimes. Geels et al. (2016) emphasised the importance of socio-technical theory in providing the context of analysing innovations and participants in a particular sector and systems. They further maintain that MLP provides an investigative framework of how new renewable technologies that evolve in niches compete with incumbent regimes described by lock-in mechanism and path dependence. The multi-dimensional tensions are formed by external developments such as demographics, disasters, economic crises and climate change (Geels et al., 2016).

According to Geels et al. (2016), the MLP advocates that socio-technical transitions emerge through the alignment of processes at the three levels as follows: internal momentum builds up at niche innovations through support from influential groups, improvement in performance or price, investment growth and processes of learning. The momentum results in pressure exerted by external developments on the incumbent regime which results in tensions and expansion opportunities for new innovative technologies. However, transition in MLP is not a linear process. It comprises many challenges and delays such as changes or reviews of government priorities and policies as a result of economic crises or when new innovative technologies face unexpected consequences (Geels et al., 2016). The MLP evaluates the possibility and viability of new renewable technologies and transition trajectories by examining the recent history of the exogenous changes, regime, and niche. This permits a comprehensive identification of present barriers and drivers that enables future informative assessments (Geels et al., 2016). The socio-technical transition theory is appropriate for this study as the study seeks to identify and describe factors that impacts growth of the SSE S PV at all the three levels of landscape, regime and niche. As the transition of South Africa's electricity industry is happening at all three levels, socio-technical transition theory was the most suitable for this study.

2.7 CONCEPTUAL FRAMEWORK

This study utilised the socio-technical transition conceptual framework. This framework was relevant to this study due to its holistic approach in looking at multiple economic, social, political, and cultural processes, as well as interactions between the three levels of landscape, regime and niche. This framework was appropriate as it does not only described how these factors affect the growth of the SSE S PV sector but also identified solutions to enable growth of the sector as indicated by Zhao et al. (2016).

This framework has been applied in several studies looking at renewable energy transitions (Beddoe et al., 2009; Ford et al., 2017; Geels et al., 2017; Sovacool & Drupady, 2011; Zhao et al., 2016). Geels et al. (2017b) utilised the socio-technical approach in their analysis of the German electricity transition from 1990 to 2016. The analysis looked at multiple economic, social, political, and cultural processes involved, as well as interactions between the three levels. Ford et al. (2017) used the MLP, together with an energy culture framework, to investigate factors enabling and limiting uptake of PV in New Zealand. The study looked at the interaction between international and national landscape, the socio-technical regime in which consumers were participating and emerging niche opportunities. In a study to examine the small renewable energy power programme in Malaysia, Sovacool and Drupady (2011) utilised the evolutionary framework for change concept first presented by Beddoe et al. (2009). According to Beddoe et al. (2009), evolutionary changes are taking place in the interconnected socio-ecological system of worldviews, institutions and technologies (WIT). Beddoe et al. (2009) suggest that these changes are important for the sustainability of current and future environmental realities. Beddoe et al. (2009) describe worldviews as views of how the world functions and what is possible, including the association between society and nature, as well as the objectives to be achieved. According to Beddoe et al. (2009), institutions refer to norms and rules, including universal structures such as the economy, governance and education. They further describe technologies as functional information and institutional mechanisms that assist in meeting set objectives.

The socio-technical framework approach of considering the interstitial nature of social, technical, economic and political factors holistically is superior when compared to other frameworks that are deterministic (Sovacool et al., 2011; Sovacool & Drupady, 2011). Zhao et al. (2016) used the socio-technical transition approach to examine the barriers to the growth of the wind power sector in China. An innovative approach that can link barriers to the transition context and identify solutions to facilitate growth is important when investigating barriers (Zhao et al., 2016). The application of the socio-technical transition framework described above has been limited in developing countries. However, the framework is relevant to developing countries including South Africa. The framework is appropriate for countries that are undergoing unbundling of their vertically integrated energy utilities and introducing emerging distributed renewable energy technologies in their energy generation mix. This study was aimed to investigate the perceptions of factors affecting growth in the small-scale embedded solar PV sector in South Africa. Its objectives were to identify and describe the perceptions of these factors as well as recommended factors that are perceived to be key drivers with regards to facilitating growth of SSE S PV sector. This framework was the most appropriate in achieving the purpose and objectives of this study.

2.8 INSTITUTIONAL FACTORS

Sovacool and Drupady (2011) maintain that institutional factors relate to policy and regulatory challenges. These include issues such as programme design, capacity caps, project approval lead times, policy and regulatory gaps. Sovacool et al. (2011) posit that institutional factors also include political dimensions such as poor institutional capacity, patronage and support of fossil fuel and grid electrification. Teng et al. (2014) maintain that one critical factor for the development of renewable energy projects is the legal and policy system. This view is affirmed by Zhao and Chen (2018) by emphasising the importance of legal and policy systems as the stimulus for the development of the industry and in ensuring equality and integrity of the renewable energy projects.

There are various factors that affect growth of the SSE S PV sector. These include the long approval process of projects, fragmented and incoherent energy policies and regulation affect the growth of the small renewable electricity market (Sovacool & Drupady, 2011). They further argue that a capacity cap prevents the organic growth of the renewable electricity market from taking place. To enable growth, critical factors which include the following: design and implementation of progressive policies, including feed-in-tariff; guaranteed access to the grid with the dominant utility; streamlined processes and effective stakeholder consultation as well as monitoring and evaluation of progress are critical (Sovacool & Drupady, 2011). It should be recognised that the view by Sovacool and Drupady (2011) is mainly the view advanced by the proponents of solar PV investment. Critical to the important factors identified above are regulation and the regulatory framework, as described below.

2.8.1 Regulation and Regulatory Framework

The importance of regulation is described as necessary to afford a modern and effective interface between the public interest, consumer interest, regulated entities' interest and interest of those utilising monopolistic infrastructure (Vasconcelos, 2005). According to Vasconcelos (2005), efficient regulation not only requires a technical framework but also needs transparent procedures that allow all interested parties to participate in the regulatory process. Nelson (2017) contends that the regulatory environment consists of three elements which are market design, pricing and systems roles and responsibilities. Nelson (2017) further suggests that the regulatory environment needs to evolve to be in line with technology and market developments. This view is affirmed by Krithika and Mahajan (2014) by proposing the need for a regulatory framework to be constantly evolving to grow penetration and greater shares emanating from renewable energy sources.

Pérez Arriaga et al. (2017) argue for a proactive reform with regards to the design of regulations to enable the effective evolution of the electricity industry. According to Pérez Arriaga et al. (2017), the emerging technologies and rapidly decreasing costs are creating a new set of tools for regulated entities to employ. This view is affirmed by Nelson (2017) by emphasising a need for the policy as well as regulation to change and adapt in line with technology and consumers' preferences. Unfortunately, this is seldom the case, as indicated by Yaqoot et al. (2016) that policy and regulation uncertainty, as well as lack of motivation of consumers, were amongst the barriers for the distribution of decentralised renewable energy systems in India.

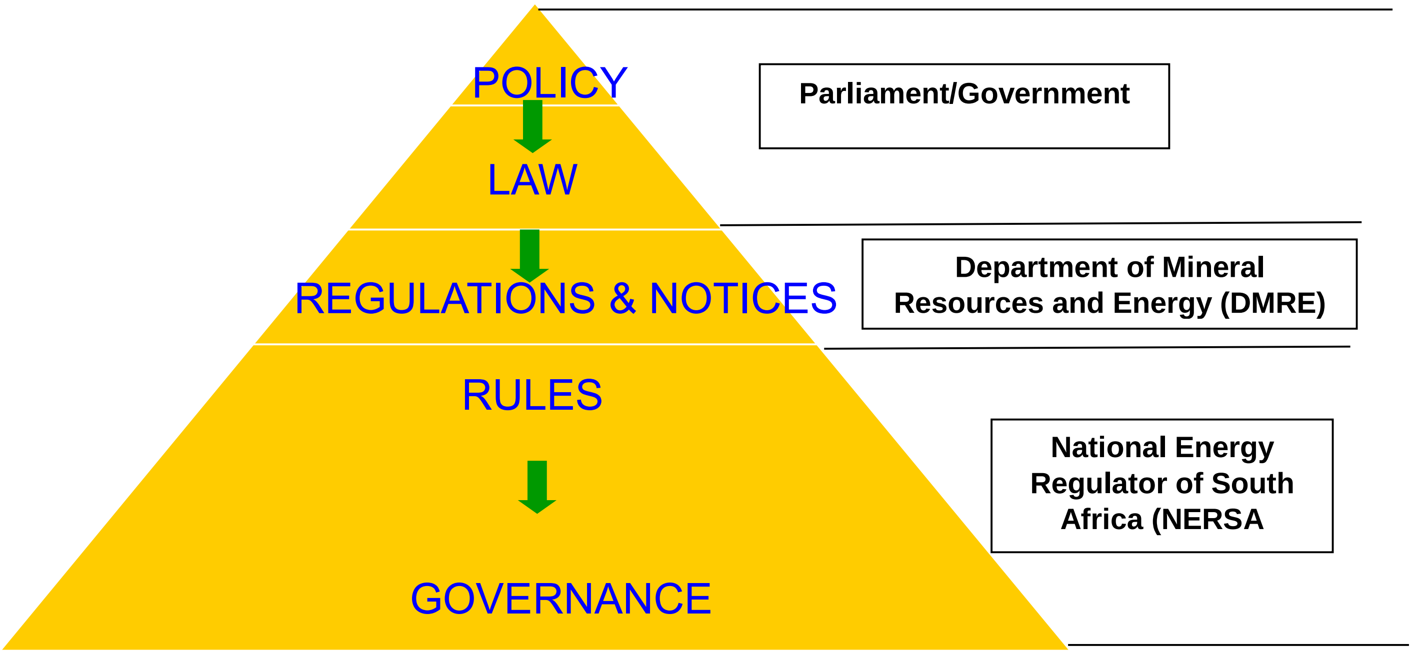
Sovacool and Drupady (2011) indicate that fragmented and incoherent energy policies and regulations affect the growth of the small renewable electricity market. According to Nelson (2017), clear regulation will assist in clearing the blurred roles between competitive markets and regulated networks. Various studies (Gboney, 2009; Knight & Mahlalela, 2019; Painuly, 2001) have identified the absence or lack of a conducive regulatory framework and uncertainty with regards to government policies as obstacles in the growth and investment in the renewable sector. Gboney (2009) further identified a lack of rules for access to the network and lack of transparency with regards to pricing for the network as other obstacles. Zhao et al. (2011) emphasise the critical role of laws, regulations and policies in regulating the growth of renewable projects. However, Baker et al. (2015) contend that rooftop solar PV technology is emerging even though there is a lack of an applicable regulatory framework.

2.8.2 Policies and Legislation

This section outlines South Africa's electricity policies and relevant legislation as it relates to PV.

Parliament and government are responsible for policy formulation as well as the law. The Ministry of Mineral Resources and Energy (DMRE) is responsible for developing policy, legislation, regulations, and notices. The development of rules, as well as governance matters such as procedures, methodologies and processes, rests with regulators such as the National Energy Regulator of South Africa (NERSA). Figure 1 below depicts South Africa's regulatory environment and legal mandate.

Figure 1: South Africa's regulatory environment and mandate



Source: Seemela (2019)

2.8.2.1 Legislation

The relevant legislation concerning electricity is indicated in table 2 below.

Table 2: Electricity relevant legislation

LEGISLATION	DESCRIPTION
National Energy Act (Act No.34 of 2008)	Ensures the availability of diverse energy mix at reasonable prices. Also provides for increased use of renewable energy and sufficient energy infrastructure investment.
Electricity Regulation Act (Act No.4 of 2006)	Provides electricity regulation framework in South Africa.

Source: Morris and Martin (2015); Ratshomo and Nembahe (2019)

The above legislation gives effect to policies noted in table 3 below.

2.8.2.2 Policies

Policies and politics are fundamental to socio-technical transitions (Markard et al., 2016). According to Markard et al. (2016), policies refer to elements of policy formulation which include regulations, programmes, goals and funding priorities. They further contend that policies are the result of a political system in response to societal problems and are also the main elements of institutional formations of socio-technical systems. Policies on technology and innovation assist in the development and dissemination of knowledge, whilst the establishment of markets and upscaling on novel socio-technical systems is enabled by developmental policies (Markard et al., 2016). According to Knill and Tosun (2012), policy relates to the policymaking process that involves interactions and negotiations among many actors. Markard et al. (2016) assert that change in policy or policies is mainly a result of politics. Various studies have been conducted to examine the interactions between advocates and opponents of renewable energy policies (Rennkamp et al., 2017; Sühlsen & Hisschemöller, 2014).

Rennkamp et al. (2017) analysed the political discourses in national debates of three countries, which are Mexico, South Africa and Thailand. The analysis aimed to gain insights into the coalitions, actors, and the arguments they were advancing to enable or prevent changes in renewable energy policies. They argue that the development of renewable energy policies is an outcome of interactions and negotiations of coalitions in support or opposition to the policies. The structure of associations of local players defines whether renewable energy projects will succeed or fail, as some players expect to gain from the project whilst others fear to lose current benefits (Rennkamp et al., 2017).

Coalition in support of renewable energy in South Africa includes civil society, investors, renewable energy industries, trade unions, government departments and academic institutions. Coalition in opposition includes Eskom, business associations as well as local and international coal industries (Rennkamp et al., 2017). They further contend that players that oppose renewables in favour of coal are citing the cost of renewable energy, high infrastructure costs, job losses as renewable energy will lead to the closure of mines, energy security and the intermittency of renewable energy. The proponents of renewable energy in South Africa mainly relate to the benefits of economic development and the reduction of emissions (Rennkamp et al., 2017).

The relevant electricity policies in South Africa are indicated in table 3 below. The Electricity Regulation Act is critical for new generation capacity such as renewable energy as it gives authority to the Minister of Mineral Resources and Energy to decide on the required additional capacity as well as its generation and procurement.

Table 3: Electricity relevant policies

POLICY	**DESCRIPTION**
White Paper on Energy Policy	Outlines the country’s energy objectives focusing on universal access, effective governance structures, competitive energy market and diverse energy supply sources.
White Paper on Renewable Energy	Sets out the goals, vision, policy principles and objectives for renewable energy in the country.
Integrated Energy Plan 2003	Provide guidelines with regards to making policy decisions whilst considering future generation capacity, consumption, reserves, energy mix and possible emissions of energy sources. It is aimed at aligning all strategies,

	development plans, international obligations and climate change mitigation strategies.
Integrated Resource Plan (IRP) 2019	Electricity infrastructure development plan based on the least cost supply and demand, to ensure the security of energy supply and minimise GHG emissions and water usage.

Source: Morris and Martin (2015)

The above policies and integration across various government levels resulted in the successful implementation of the renewable independent power programme.

Nhamo and Ho (2011) argue that the policy on the feed-in tariff (FIT) was important for investment. However, Sovacool and Drupady (2011) argue that FIT levels are not sufficient on their own to promote renewables. They further maintain that there should be penalties for non-compliance, particularly when the dominant utility has opposed renewable energy before. The REI4P programme had challenges. According to Nhamo and Ho (2011), one of the challenges includes the different definitions of renewable energy in various government legislations. The different definitions result in difficulties when it comes to implementation (Nhamo & Ho, 2011).

2.8.3 SSEG Policy Framework

The SSEG policy and regulatory framework should be understood in the context of the renewable energy programme.

2.8.3.1 Electricity Regulation Act, 2006

This act provides a regulatory framework for SSEGs in South Africa. Schedule II of the Act is critical to the growth of the SSEG sector in South Africa.

Schedule II is about the exemption from the requirement “to apply and hold a license in any generation plant constructed and operated for demonstration purposes only and not connected to the interconnected power system, any generation plant constructed and operated for own use and non-grid connected supply of electricity except for commercial use” (Republic of South Africa, 2006).

The Minister of Mineral Resources and Energy gazetted the ‘Licensing Exemption and Registration Notice on 10 November 2017’. The Notice outlines activities that are exempted ‘from the requirement to apply for and hold a license under the Electricity Regulation Act. This includes the registration of these activities with the National Energy Regulator of South Africa” (*Licensing Exemption and Registration Notice*, 2017).

Following the gazetted Notice, NERSA developed a registration procedure and process for SSEGs. NERSA’s Registration Procedure for SSSEGs (2018) outlines the purpose of the procedure is to:

- ensure orderly growth of electricity supply infrastructure;
- establish guidelines under which the Energy Regulator must register generation facilities with a capacity of 1MW or less to ensure compliance with the Act;
- establish processes and procedures to be followed when registering generation facilities with a capacity of 1 MW or less;
- provide reporting requirements for registered generation facilities with a capacity of 1MW or less; and
- ensure that NERSA has an up-to-date database of installed generation facilities that need to be registered in terms of the Notice to enhance regulation and inform policy formulation.

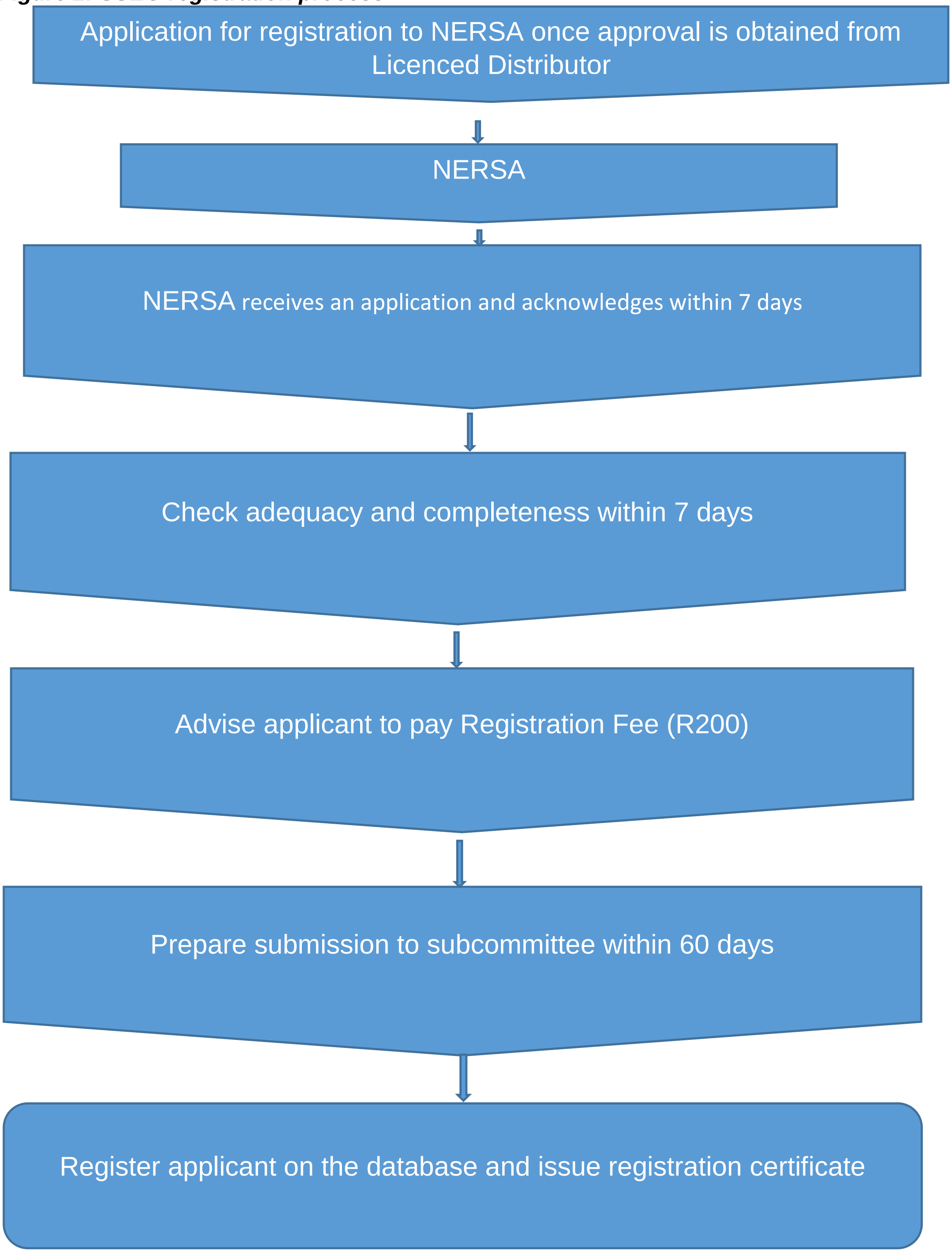
The Registration Procedure further identifies generation facilities that are eligible for registration, as per Licensing Exemption and Registration Notice of 2017. The registration procedure further indicates the registration requirements for eligible generators as follows:

- consent letter from the licenced Network Service Provider (NSP);
- power Purchase Agreement between the generator and the consumer;
- wheeling agreement with NSP; and
- registration application to be done by the owner/operator.

2.8.3.2 SSEG Registration Process

The NERSA registration process for SSEGs is indicated in figure 2 below.

Figure 2: SSEG registration process



Source: NERSA (2018)

2.9 TECHNICAL FACTORS

Sovacool and Drupady (2011) identified technical challenges to include the development of renewable electricity systems that are appropriate to the respective country's context, lack of skills and inadequate training. Thopil et al. (2018) identified the technical impact of connecting to the grid to include a quick increase and decrease in voltage levels as a result of the intermittent nature of distributed generation electricity, reduction in quality of electricity and not able to meet the required load during load shedding. In this regard, an energy model that is a hybrid of coal as baseload and renewable energy as a peak load is recommended to offer a consistent and sustainable power generation (Thopil et al., 2018). Thopil et al. (2018) further suggest that renewable energy such as solar PV should be designed with power storage batteries because of the non-dispatchable formation of renewable energy.

The other identified technical challenge relates to exorbitant costs for project feasibility and connecting to the grid (Sovacool & Drupady, 2011). The following is a description of the small-scale embedded generation technology.

2.9.1 Small Scale Embedded Generation (SSEG)

There are various terms and definitions for SSEG and these include distributed, dispersed, and decentralised generation. Definitions also vary in the literature.

SSEG is defined as an electricity generator that is connected directly to the end-user side of the meter (Ackermann et al., (2001). Mkhwebane and Ntuli (2019) define SSEG as electricity producers situated in domestic or industrial areas where power is normally utilised. The NERSA Registration Procedure for Small-Scale Embedded Generators (2018, p. 3) defines SSEG to mean "a customer that operates a generation facility of ≤ 1 MW and connected at low voltage to a Public Distribution System". In the electricity industry parlance, it is generally referred to as 'the other side of the meter' i.e. on the customer's side of the meter. For this study, the definition of SSEG as described in the NERSA Registration Procedure for Small-Scale Embedded Generators (2018) is utilised.

The Integrated Resource Plan (2019) indicates the increase in the number of own generation facilities, such as solar rooftop PV (SR PV), mostly in residential areas. However, commercial, and industrial facilities are also installing solar PV systems to supplement electricity from the grid. The move to own generation by both residential and commercial sectors can be attributed to various factors such as the changing electricity landscape, advances in technology and high electricity prices.

According to Filipova and Morris (2018), the Renewable Energy Independent Power Producer Procurement Programme (REI4P) created an entry point for SSEG to be part of the electricity value chain by entering the generation space. Mkhwebane and Ntuli (2019) argue that solar PV is the preferred technology because it utilises the free sun, low maintenance costs, reliability, and it is easy to install and deploy. Filipova and Morris (2018) further view SSEGs as part of a universal movement geared towards decentralising the electricity generation sector. They further argue that SSEGs can disrupt the electricity value chain by enabling new players to participate in the electricity generation sector. This is confirmed by Baker and Phillips (2019, p. 179). They argue that even though SSEG generated electricity is still negligible as compared to the national capacity, it still presents an opportunity to “reconfigure systems of electricity generation, distribution and transmission”.

SSEGs are disrupting the vertically integrated electricity value chain in South Africa. According to Mkhwebane and Ntuli (2019), electricity consumers are moving to embedded generation due to the increasing cost and unreliability of electricity supply. Mkhwebane and Ntuli (2019) further maintain that rooftop solar PV is regarded as critical to sustainability initiatives due to low emissions, affordable energy as well as not being centralised. They maintain that there are numerous options for implementing SSEG and these include own consumption and grid connection to feedback access capacity, producing power for a particular customer which requires an agreement to wheel the power using the grid and for own use without connection to the grid, normally using energy battery storage.

According to Mkhwebane and Ntuli (2019), the SSEG sector has a long history in South Africa. They argue that solar PV technology, with few small-scale installations, was introduced in the 1980s. These were mainly off-grid and in rural areas. Breyer and Gerlach (2013) maintain that commercial-scale installations started happening in the 1990s. Edkins, Marquard and Winkler (2010) noted that most of the PV systems installed in South Africa were mainly small scale (below 1MW). These PV systems were mostly off-grid and installed in largely rural areas where extending the grid connection was high. However, with the rapid speed of technology development and the accompanying decreasing costs, small-scale solar PV installations are gaining traction in urban areas.

However, there are challenges in the SSEG sector. These challenges include the absence of a regulatory framework, awarding permits and grid connection (Mkhwebane & Ntuli, 2019). Baker and Phillips (2019) contend that notwithstanding the lack of applicable policy and regulation certainty at a national level, the challenges of increasing electricity prices and power shortages have resulted in consumers that can afford to install solar PV technology. Filipova and Morris (2018) contend the policy and regulation uncertainty at the national level resulted in municipalities developing their framework of rules and processes that allow SSEGs of up to 1MW to connect to the distribution network. Filipova and Morris (2018) argue that even though the rules vary across the different municipalities, they all focus on technical compliance and the net-consumer requirements. Net-consumer requirements entail that customers with an SSEG system connected to the municipal grid are expected to consume more electricity annually than what they feed back.

2.10 ECONOMIC FACTORS

Economic factors refer to low electricity tariffs, the resistance of financiers and bankers, subsidies for fossil fuel electricity generation and the failure to include the cost of externalities in electricity prices.

Sovacool and Drupady (2011) identified unpredictably and uncertainty with regards to electricity tariffs as a problem affecting the growth of the small renewable sector. They further identified the lack of capital and financing as economic and financial barriers.

Filipova and Morris (2018) identified balancing supply and demand, storage costs, and cost of electricity from SSEG as obstacles or barriers for implementation of SSEG in four metros of Johannesburg, Ekurhuleni, eThekwini and City of Cape Town.

2.11 SOCIAL FACTORS

Zhao and Chen (2018) identified social factors affecting the growth of renewable energy programmes in China to include incentive policies, the willingness of financial institutions to fund the renewable energy projects, the willingness of developers to invest in the projects and the willingness of the consumers to pay for the renewable electricity. They further contend that the social acceptance of policymakers depends on the formulation of policies that support renewable energy projects.

Developers of renewable energy projects play a critical role as they are responsible for the construction and production of renewable energy. The critical role relates to their preparedness to invest in these projects (Zhao & Chen, 2018).

Yousefi-Sahzabi et al. (2017) maintain that acceptance by consumers is a prerequisite before initiating any renewable energy projects. The acceptance is reflected in the consumer's preparedness to pay for renewable energy (Yuan et al., 2015). According to Yuan et al. (2015), the high prices of renewable energy make it difficult for the general public to accept renewable energy when compared to fossil fuel energy such as coal.

According to Carlisle et al. (2015), social factors can either facilitate or hamper the development of renewable energy projects.

2.12 CONCLUSION OF LITERATURE REVIEW

Several studies on renewable energy transitions utilised the socio-technical transition approach (Beddoe et al., 2009; Ford et al., 2017; Geels et al., 2017; Sovacool & Drupady, 2011; Zhao et al., 2016). Literature (Sovacool et al., 2011; Sovacool & Drupady, 2011) suggests that an holistic and socio-technical approach, rather than a mere account of technological innovation, is appropriate in reviewing energy technologies. Socio-technical approaches encompass political, technical, economic, and social factors (Sovacool et al., 2011; Sovacool & Drupady, 2011).

Beddoe et al., (2009) contend that institutions refer to norms and rules including universal structures, such as the economy, governance, and education. Technologies are functional information and institutional mechanisms that assist in meeting set objectives (Beddoe et al., 2009). Sovacool and Drupady (2011) maintain that institutional factors relate to policy and regulatory challenges. These include issues such as programme design, capacity caps, project approval lead times, policy, and regulatory gaps.

In the review of distributed generation with PV grid-connected systems in Brazil, de Faria et al. (2017) identified financial, technical and political factors as barriers that affect the development of PV grid-connected systems in developing countries. Based on the literature review, this study examined factors affecting growth in the SSE S PV sector in South Africa from a multi-level perspective approach. The study investigated the socio-technical factors affecting growth in the SSE S PV sector as well as the interaction within and between the three levels of niche, regime, and landscape as informed by literature review. This includes institutional, technical, economic, financial, and social factors.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 INTRODUCTION

The research methodology chapter describes the method the study followed in examining perceptions of factors affecting growth in the SSE S PV sector in South Africa.

The sections covered include research approach, design, data collection method as well as the research population and sample. The section further looks at the instrument used for collecting data, how data was collected, how data was analysed and the limitations the study encountered. The section concludes by discussing the study's transferability, dependability, credibility, confirmability, and demographic profile of respondents.

3.2 RESEARCH APPROACH

The two main research approaches are qualitative and quantitative. Antwi and Hamza (2015) describe quantitative research as an approach that follows the confirmatory method and focuses on hypothesis testing using empirical data to check the existence of a relationship. Qualitative research is used to generate new hypotheses or theories and is mainly used to discover more about a topic or phenomenon (Antwi & Hamza, 2015).

Bryman and Bell (2015) define qualitative research as a research approach that gives significance to words compared to numbers when collecting data and conducting the analysis. According to Borbasi and Jackson (2012), qualitative research is used to investigate personal experience without using statistical data analysis. It is used to uncover trends in thoughts and opinions.

This study utilised a qualitative research approach. A qualitative approach was appropriate for this study as it aimed to uncover insight and views (Sovacool et al., 2011; Sovacool & Drupady, 2011)

3.3 RESEARCH DESIGN

Literature defines research design as a blueprint (Zikmund, Babin, et al., 2013) and a system (Bryman, 2016) that is used to describe the research questions and the objective or aim of the study (Cooper & Schindler, 2011).

This study utilised a semi-structured interview guideline to collect primary data. The initial plan was to conduct face-to-face interviews to collect data. However, this was changed due to the COVID-19 pandemic and the need to comply with the relevant COVID-19 Regulations and protocols.

COVID-19 was not anticipated at the time of deciding on the research design and data collection approach. The researcher changed from conducting face-to-face interviews to using Microsoft Teams, telephone calls as well as requesting respondents to self-complete the semi-structured interview guide.

The interview guide was sent to the respondents before the interview. This was to enable the respondents to familiarise themselves with the questions. After the interviews were conducted, the researcher transcribed the interviews as well as coded and categorised them into different themes. A thematic analysis of the collected data was conducted.

The study interviewed a wide range of stakeholders that have experience, expertise, and knowledge of the energy industry in South Africa. Their expertise varies from policy development, regulation, funding of renewable projects, authors/writers, analysts, utilities, municipalities, and associations in the energy sector. These stakeholders also hold managerial and senior positions in their respective organisations. A total of thirteen (13) respondents participated in the study.

3.4 POPULATION AND SAMPLE

3.4.1 Population

The population is described as the universe of components or elements out of which the selection of a sample is conducted (Bryman & Bell, 2015). According to Zikmund, et al. (2013), people that are selected for the research have similar qualities.

The population of this study consist of experts within various stakeholder groups with varied expertise and knowledge in the energy industry in Johannesburg. Table 5 below indicates the population of this study.

Table 4: Study Population

Stakeholders
Department of Mineral Resources and Energy (DMRE)
Independent Power Producer (IPP) Office
National Energy Regulator of South Africa (NERSA)
South African PV Industry Association (SAPVIA)
South African Local Government Association (SALGA)
Farmers Association (Agri SA)
Shopping Malls/Centres
Municipality
Eskom
Development Bank of South Africa (DBSA)
Industrial Development Cooperation (IDC)
Commercial Banks
Academia
Energy expert
Energy Intensive User Group (EIUG)
Coal industry

3.4.2 Sample and sampling methods

According to Bryman and Bell (2015), sampling relates to the recording of all components of the population to be utilised in selecting survey participants. It is described as a selected section of the population for research (Bryman, 2012).

Purposive sampling, which is sometimes called selective sampling, relies on the researcher's judgement regarding the selection of people to be surveyed and the sample is relatively small (Rai & Thapa, 2015). A purposive sampling strategy was utilised for this study. Purposive sampling is appropriate for this research as the study sought to gain insight from respondents regarding factors that affect growth in the SSE S PV sector. The sample for this study consists of respondents with knowledge, expertise, and interest in the SSE S PV sector in South Africa. In this regard, respondents have knowledge and interest in the matter and this enabled them to answer the questions.

The sample size for this study was to conduct fifteen (15) interviews with stakeholders that have knowledge, expertise, and interest within the SSE S PV sector. The total number of interviews conducted for this study was thirteen (13). One respondent could not participate due to pressing work commitments. The stakeholder agreed to participate in the interview which was to be conducted virtually on Microsoft Teams but he was not able to join the meeting due to work commitments. The other stakeholder could not participate due to illness. The stakeholder was infected with the coronavirus and was in quarantine.

The sample size was appropriate for this study. According to Thapar and Sharma (2020), there is no precise sample size for studies that seek to elicit expert opinions.

The literature on expert elicitation (Ford et al., 2017; Sovacool & Drupady, 2011; Zhao et al., 2011; O'Hagan et al., 2006 as cited in Thapar and Sharma, 2020) emphasises the significance of the expert's knowledge on the subject matter rather than the number of experts. Numerous experts beyond a particular level may not add any value to a study (Clemen & Winkler, 1999 as cited in Thapar and Sharma, 2020). “Some of the scholarly exercises on energy technologies relied on merely three to seven experts” (Thapar & Sharma, 2020, p.209).

3.5 THE RESEARCH INSTRUMENT

A research instrument is defined as a tool that is used to gather the information that will enable a researcher to investigate a solution to a research problem (Bryman, 2016; Zikmund, et al., 2013).

The research instrument utilised for this study was an interview guide. The interview guide consisted of open-ended questions and was semi-structured. This enabled flexibility for the respondents to give more insights into their responses.

According to Woods (2011), open-ended questions enable the researcher to ask probing questions such as: Would you give me an example? Would you explain that further? and can you elaborate on that idea? This study followed the five phases suggested by Kallio et al. (2016).

The interview guideline for this study consisted of the following six semi-structured questions:

1. What would you say are the factors that affect (both positive and negative) the growth of the small-scale embedded solar PV sector in South Africa?
2. How would you describe or in which manner are these factors affecting the growth of the small-scale embedded solar PV sector in South Africa?
3. What would you suggest as solutions to enable growth in the small-scale embedded solar PV sector in South Africa?
4. What are the factors that you perceive can drive the growth of the small-scale embedded solar PV sector in South Africa?
5. What would you describe as challenges or obstacles facing the small-scale embedded solar PV sector in South Africa?
6. What suggestions or improvements that can be made to enable growth in the small-scale embedded solar PV sector in South Africa?

The above questions were structured following interview questions in studies conducted by several authors (Ford et al., 2017; Sovacool & Drupady, 2011; Zhao et al., 2016). Zhao et al. (2016) formulated the interview questions for the participants to comment on the obstacles they perceived to be prohibiting the growth of wind power in China. Ford et al. (2017) structured the interview questions in such a manner to assist and identify the main factors involved in the adoption of solar PV in New Zealand. Sovacool and Drupady (2011) designed their interview questions to facilitate the identification of the main challenges for small renewable power in Malaysia.

3.6 DATA COLLECTION METHODS

The data collection for this study was mainly through respondents self-completing the semi-structured interview guide. The interview participants were first approached by telephone, WhatsApp/SMS messages and emails, requesting them to participate in the study. Respondents who agreed to participate were provided with the semi-structured interview guide and an email explaining the ethical considerations and what was expected from them.

The interview participants were also requested to indicate whether they would prefer self-completing the semi-structured interview guide, telephonic interview, or interview via Microsoft Teams. The majority of participants preferred to self-complete the semi-structured interview guide. This was mainly due to their time constraints and self-completion of the interview guide provided them with the flexibility to complete in their own time. However, they also offered the researcher an opportunity to make follow-up questions or clarifications when needed.

In this regard, the researcher did request some clarifications from the respondents. The clarifications were mainly requests for certain statements to be expanded or described in more detail. This assisted the researcher to have a better understanding and perspective of the responses.

Only two (2) participants requested that the interview be conducted via Microsoft Teams and one (1) participant requested a telephonic interview. However, only one Microsoft Teams interview was conducted as the potential interview participant could not make it due to work commitments. Regarding these two interviews, the researcher also asked follow-up questions that prompted reflection by the interview participants to some of the responses provided.

The interview guide was sent to all respondents before the interviews. This was to enable the respondents to familiarise themselves with the questions. The interviews were successfully conducted via MS Teams and via telephone. The interviews lasted approximately 45 minutes.

The stakeholders interviewed represent a wide range of expertise in the energy industry which includes policy, regulation, commercial banks, utilities, financial, energy experts as well as energy journalists and analysts. Table 4 below indicates the stakeholders who participated in this study.

According to Thapar and Sharma (2020, p.208), various researchers "employed expert interviews (survey) to gain insights on variables impacting the growth of renewable energy in different geographies" (

Table 5: Stakeholders that participated in the study

Stakeholders
Department of Mineral Resources and Energy (DMRE)
National Energy Regulator of South Africa (NERSA)

South African Local Government Association (SALGA)
Municipality
Eskom
Commercial Bank
Energy Analysts
Energy journalists
Energy Experts

3.7 DATA ANALYSIS AND INTERPRETATION

The study used a thematic interpretation of the data collected. Thematic analysis was based on themes emerging from the collected data. Braun and Clarke (2006, p. 79) describe the thematic method as “a method for identifying, analysing, and reporting patterns (themes) within data. It minimally organises and describes your data set in (rich) detail”.

3.7.1 Transferability

Tracy (2010, p. 845) maintains that transferability relates to "readers feel as though the story of the research overlaps with their situations and they intuitively transfer the research to their action".

Transferability was achieved by providing deep and rich descriptions and direct quotations from the respondents.

3.7.2 Dependability

Dependability refers to whether the findings of the qualitative study will be applicable at other times (Bryman & Bell, 2015).

The dependability of this study was achieved by keeping records as well as collected study information safe and will be made available and accessible for any verification that might need to be conducted. This information includes all research processes: problem formulation, selection of respondents, transcripts, interview guides, notes and data analysis.

3.7.3 Credibility

Credibility is described by Tracy (2010) to relate to trustworthiness and plausibility. Tracy (2010) asserts that credibility in qualitative research can be achieved through practices that include thick description, triangulation, multivocality and partiality.

The credibility of this study was achieved through triangulation by analysing data from primary and secondary sources.

3.7.4 Confirmability

Bryman and Bell (2015) describe confirmability as making sure that the researcher's subjectivity does not influence the findings.

Confirmability of this study was achieved by the declaration of any interest the researcher might have and by clearly indicating the study's objectives, purpose as well as findings.

3.8 ETHICAL CONSIDERATIONS

The significance of ethical considerations by researchers has been emphasised by various researchers(Bryman & Bell, 2015; Bryman, 2016; Cooper & Schindler, 2007).

In this regard, literature maintains that researchers should always consider ethical considerations including declaring any interest they might have, ensuring interview participants' safety, agreement to be interviewed and privacy when conducting research.

The researcher took all the above ethical considerations in conducting the study. The researcher is an employee of the National Energy Regulator of South Africa. In this regard, the researcher disclosed this information to the interview participants and assured them that the information provided would be treated with confidentiality and would be solely used for academic purposes. The researcher sent a declaration in an email, indicating that the study is not related to the business of NERSA but is a research project as a requirement for the completion of his studies.

CHAPTER 4: RESEARCH FINDINGS

4.1 INTRODUCTION

This chapter presents the findings of the study. The findings are guided by two key research questions of this study which are:

- what barriers are affecting growth in the SSE S PV sector in South Africa; and
- what are the key drivers for growth in the SSE S PV sector in South Africa?

The findings are presented by indicating the positive and negative factors that affect the growth of the sector as identified from the study. This is followed by the description of the challenges as well as identified solutions that can enable the growth of the SSE S PV sector. These findings are classified into four themes as detailed below.

4.2 DEMOGRAPHY OF RESPONDENTS

Respondents of this study consist of a wide range of stakeholders in the energy industry which includes policy, regulation, commercial banks, utilities, financial, energy experts as well as energy journalists and energy analysts.

The demographic profile of respondents reflects the profile of key stakeholders which include all genders, races and they occupy senior and executive positions in their respective organisations.

To ensure the anonymity of the respondents, the 13 interview participants are labelled as Participant A, Participant B, Participant C, Participant D, Participant E, Participant F, Participant G, Participant H, Participant I, Participant J, Participant K, Participant L, Participant M:

4.3 RESEARCH FINDINGS

Four distinct themes were identified from the study and these are:

- Theme 1: Factors positively affecting the growth of the SSE S PV sector in South Africa
- Theme 2: Factors negatively affecting the growth of the SSE S PV sector in South Africa
- Theme 3: Challenges facing the SSE S PV sector in South Africa
- Theme 4: Solutions to enable the growth of the SSE S PV sector in South Africa

Themes 1, 2 and 3 address the first question: *What barriers are affecting growth in the SSE S PV sector in South Africa?* And Theme 4 answered the second question: *What are the key drivers for growth in the SSE S PV sector in South Africa?* The following is a detailed discussion of the four themes.

4.3.1 Theme 1: Positive factors affecting the growth of the SSE S PV sector

Participants were asked to indicate and describe factors that affect the growth of the SSE S PV sector in South Africa. The majority of participants indicated the following factors which are categorised as positively affecting the growth of the SSE S PV sector in South Africa:

- Good solar irradiation or abundance of sun resources.
- The high electricity tariffs of both Eskom and Municipalities.
- Technology - this relates to the rapidly decreasing prices of solar PV technology.
- Enabling policy and regulation environment.
- Load shedding - the current power capacity shortages in the country causing the supply to be unstable and unreliable.
- The need for reduction of greenhouse gases (reduction of carbon emissions).
- Incentives such as feed-in tariffs and net metering.

4.3.1.1 Description of positive factors affecting the growth of the SSE S PV sector

Participants were requested to described how these factors affect the growth of the SSE S PV sector. The respondents provided the following descriptions and direct citations are reflected in italics.

4.3.1.1.1 Solar resources

The respondents indicated that South Africa has an abundance of the sun. This has resulted in good solar irradiation which contributes to the positive growth of the SSE S PV sector in South Africa.

Participant A responded by indicating that: *"Good solar irradiation results in higher energy yield, which makes SSEG attractive."*

This view was supported by Participant B, who indicated that *"South Africa has abundant sun resources and as such, SSEGs can be installed anywhere in the country."*

4.3.1.1.2 Tariffs

The increasing electricity tariffs for both Eskom and the Municipalities (as the two main electricity distributors in the country) were identified as impacting the SSE S PV sector. The increasing electricity tariffs are pushing organisations to install SSE S PV technologies to control the increasing costs.

Participant B stated the following: *"High Eskom and Municipal prices are encouraging consumers to install SSEGs in their homes as well as agricultural, commercial and industrial sectors in their respective premises."*

Participant A and F also supported the perception that increasing electricity tariffs positively affect the growth of the SSE S PV sector. Participant A described the positive influence as follows: *"The current high tariffs of both Eskom and Municipalities, with no clear price path is also pushing people to invest in SSEG and increase growth in this sector."*

Participant F commented that tariff has a positive influence because *"The rising tariffs make electricity bills unaffordable and therefore it makes sense to install your own energy solutions."*

4.3.1.1.3 Technology

Respondents identified technology as a factor that affects the growth of the SSE S PV sector in South Africa. Participants described technology regarding the decreasing prices of solar PV technology and the speed at which this technology is maturing.

Participant A indicated that *"The falling prices of renewable energy technologies over the past decade, especially for solar and wind is making them more attractive."*

This view was affirmed by Participant I who commented that "*There has been a substantial reduction in solar PV technology prices over the past decade which is good news for the sector."*

Participant J commented that "*The speed at which the solar PV technology is maturing is very fast, it's growing very rapidly. Solar panels and inverters that were bought three years ago are now obsolete."*

Participant L also supported this perception and indicated this as the main reason that positively affects the growth of the sector *"Customers are finding it more feasible to install SSEG due to decreasing costs (stemming from increasing demand and improvements in efficiency) as they save on their electricity bills."*

4.3.1.1.4 Policy and regulation

Policy and regulation were also identified by respondents to affect the growth of the SSE S PV sector. Participants indicated that enabling policy and regulation provides a conducive environment to stimulate the growth of the sector.

Participant B described how policy and regulation affect the growth of the sector as follows: "*Enabling regulation (amended regulation for new generation capacity) and notice (licencing exemption and registration notice) from DMRE as well as Ministerial letter directing NERSA to licence own-use generation without complying with Section 10.2(g) of the Electricity Act which states that Ministerial approval must be obtained to deviate from integrated resource plan"*.

Participant B further indicated that: *"Enabling NERSA registration procedure for SSEGs with an output of no more than 1MW and licencing regime for SSEGs that have capacities of out of more than 1MW."*

Participant A commented that *"Removal of the regulatory burden and red tape on registration process would positively contribute to the growth of SSEGs in South Africa."*

4.3.1.1.5 Load shedding

Load shedding or power cuts was identified as another factor that contributes to the growth of the SSE S PV Sector. Participants E and G indicated capacity shortages and the resultant unreliability of supply as pushing people to the SSE S PV sector. Participant E described that *"The current power capacity shortages in the country is causing supply to be unstable and unreliable, which necessitate organisations to install SSE S PV technology."*

Participant C indicated that *"Load-shedding is another big driver, with PV and batteries are seen, increasingly, as a viable and cleaner alternative to a diesel generator."*

Participant F responded that *"Shortage of power capacity and load shedding is making citizens decide to take the energy issues in their hands and gradually move off the grid."*

4.3.1.1.6 Greenhouse gases

The reduction of greenhouse gas emissions was identified as a factor that contributes to the growth of the SSE S PV sector.

Participant F responded that *"Citizens have become more aware of global environmental issues and therefore do not want to contribute to the use of power generated using fossil fuels."*

4.3.1.1.7 Incentives

Participants indicated that the introduction of incentives such as feed-in tariffs and net metering positively affect the growth of the SSE S PV sector.

Participant B stated that to encourage the growth of SSE S PV, *"Licencees such as Eskom and Municipalities have put in place SSEG tariffs to encourage the installation of embedded generation."*

4.3.2 Theme 2: Negative factors affecting the growth of the SSE S PV sector

Participants were asked to indicate and describe factors that affect the growth of the SSE S PV sector in South Africa. The majority of participants indicated the following factors which were categorised as negatively affecting the growth of the SSE S PV sector in South Africa:

- Intermittency of solar PV technology
- Regulatory uncertainty
- Affordability
- Lack of incentives
- Incumbency
- Revenue loss
- Technology

4.3.2.1 Description of negative factors affecting the growth of the SSE S PV sector

Participants were requested to describe how these factors affect the growth of the SSE S PV sector. The respondents provided the following descriptions and direct citations are reflected in italics.

4.3.2.1.1 Intermittency of solar PV technology

The intermittency of solar PV technology was identified by most participants as affecting the growth of the SSE S PV sector.

Participant A explained that *"The intermittency of the solar resources makes them unattractive for industrial operation or grid operation, making them unattractive."*

Participant B indicated that the most preferred technology in SSEG is solar. However, the *"production of electricity is reliant on the availability of the sun and if the sun is not available then the SSEG is not useful."*

Participant B further indicated that a high concentration of SSEG *"may pose a problem to the national grid in that the electricity from SSEG is intermittent."*

4.3.2.1.2 Regulatory uncertainty

Participants identified a lack of a clear regulatory environment as a factor that impact growth of the SSE S PV sector. Respondents indicated that inadequate, unclear, and slow regulatory processes affect the growth of the sector.

In describing how the regulatory environment affects the growth of the sector, Participant A responded that *"Currently, the applicants are required to submit consent letters to NERSA from the licenced distributors where these plants are connected. Unfortunately, the process of obtaining these is cumbersome."*

Participant C explained that *"The regulatory and policy problems remain an overwhelming drag on yet further deployments."*

This view was further affirmed by Participant C when emphasised that *"The negative factors remain the difficulties in navigating the regulatory environment and the lack of clear municipal/Eskom policies."*

Participant G also commented on the slow regulatory processes and responded that *“Regulation and slow processes from NERSA remains a stumbling block.”*

Participant J indicated that *“NERSA is dragging its feet (delaying) in coming up with rules for the sector.”* Participant J further indicated that *“The regulatory uncertainty contributes to the reluctance by investors to invest in the sector.”*

4.3.2.1.3 Affordability

Affordability was identified as a factor that affects the growth of the SSE S PV sector. Participants indicated that the inability of consumers to afford to install solar PV technology and the high cost of energy storage batteries affect the growth of the sector.

Participant B responded that *“Lack of financial muscles to fund the SSEGs for household and other consumers (agricultural, commercial & industrial) affect the growth of the sector."* Participant B further indicated that *“The backup system such as battery storage is very expensive and the technology is not fully matured.”*

Participant D also raised the affordability factor, indicating that *“Negative factors include the pricing of solar PV that is still prohibitive for small households.”*

Participant B indicated that *"Only rich consumers can afford to install SSEGs otherwise poor household cannot derive benefit from the installation of SSEG as they cannot afford."*

Participant M commented that *“Perhaps the price is still out of reach for the average person.”*

4.3.2.1.4 Lack of incentives

Participants mentioned that lack of incentives such as a feed-in tariff or unpalatable feed-in tariffs in most jurisdictions affects the growth of the SSE S PV sector.

Participant C stated that *“the absence of feed-in prospects in most jurisdictions, or unpalatable feed-in tariffs.”*

Participant E explained that *"Inability to sell the excess to the grid to recover some of the outlay is a problem."*

Participant F indicated that growth of the SSE S PV sector is affected by *"The lack of incentives in the utility feed-in tariffs to install more solar PV for it to make financial sense."*

4.3.2.1.5 Incumbency

Respondents indicated that Eskom is stifling the growth of the SSE S PV sector.

Participant J explained that *“The Eskom voice is stifling the growth of the industry. Eskom is influencing the DMRE and NERSA*.” Participant J further stated that *“NERSA is not independent to tell Eskom that they should allow unbiased access to the grid.”*

4.3.2.1.6 Revenue loss

Respondents indicated that the fear of losing revenue by municipalities and Eskom affects the growth of the SSE S PV sector.

Participant F explained that the SSE S PV sector *“Can be seen as negatively affecting the revenues of the electricity utilities.”*

Participant C responded that *"South Africa's volume-based pricing policy, where bills are based on kilowatt-hours sold with low service charges, is a real problem, as municipalities are naturally reticent to promote rooftop solar, as they have no way of recovering the revenue that is lost from rich consumers and run the risk of being left only with consumers who are unable to pay."*

4.3.2.1.7 Technology

The technology was identified as a factor that affects the growth of the SSE S PV sector. This relates to technical problems such as technology obsolescence, installations, and grid connections.

Participant B indicated that *“High penetration of SSEG in the national grid creates instability in the operation of the power system.”*

Participant C stated that *“Some problems in finding reputable installers.”*

Participant E explained that the *“Fast rate of technology obsolescence affects the growth of the sector."*

Participant B further explained that SSEGs are not helpful during load shedding if they are connected to the grid, *“when there is load shedding the SSEG is not able to provide electricity especially if it’s tied to the grid, which is the case with SSE S PV.”*

Respondents identified the registration limit of generation facilities of up to 1MW as affecting the growth of the sector. Participant G suggested as follows: "Open up the market by allowing 1-10MW to also just register rather than a licence." This was supported by Participant A who proposed that "The threshold for registration should also be increased to between 5-10MW to encourage businesses from benefiting from economies of scale."

4.3.3 Theme 3: Challenges facing SSE S PV sector

The participants were asked to identify challenges facing the SSE S PV sector in South Africa. Participants mentioned the same factors classified as negatively affecting the growth of the SSE S PV sector. These factors include the following: lack of funding, regulatory burden, absence of back-up generation to support SSEGs, delay in granting of environmental permits and other permits for SSEGs, high costs, unattractive feed-in tariffs for SSEGs, lack of clear regulatory framework and rules of engagement as well as perception by utilities that SSEGs diminish their revenues.

Respondents also identified the limited balance sheet capacity of off-takers and the fact that payment terms of funding need to be a bit longer to be able to support a lower tariff.

Participant A explained that *“One of the biggest challenges is the different approval processes that one has to obtain before being registered (connection consents from municipalities or Eskom), as well as approval from NERSA."*

Participant M identified challenges to include the *“lack of local production facilities as well as the lack of significant development of battery storage or storage technology to augment the harnessing of natural resources.” Participant M further indicated that “it is still a new industry, it will trickle down slowly while the economics and acceptability are improved.”*

Participants also raised communication or creating awareness of this alternative electricity generation technology as a challenge. Participant M contends that “*There has not been a serious campaign to make people aware of all the options except the* *focus on conventional systems.* Participant M further commented that *“the impediment is lack of knowledge by consumers and they must be assisted.”*

Participant M indicated that *“People are generally not aware of the options available when it comes to alternate ways of energy provision."*

The other challenges identified were technically related to suppliers, installers as well as accreditation.

Participant K indicated that challenges are *“unethical suppliers and installers, affordability and accreditation.”*

Participant L commented that *“Poor understanding of the technology, such as customers getting an impression that the system will work without batteries during load shedding, which is incorrect.”* Participant L further commented that *“Regulation is also not concluded for all impacts of the technology – wiring code still being published and NRS standards being amended.”*

4.3.4 Theme 4: Solutions that can drive the growth of the SSE S PV sector

Participants were asked to suggest solutions that can assist in enabling the growth of the SSE S PV sector. Participants mentioned issues such as net-metering, tax incentives, quick registration process, clear regulatory framework, feed-in tariffs and improved communication or public awareness.

Participant A indicated that the introduction of *“net-metering tariffs where SSE S PV plants are allowed to sell back to the grid may drive growth.”*

Participant D responded that *“Tax incentives can assist where the cost is too high.”*

Government intervention with regards to providing incentives was identified by participants as a solution that can enable the growth of the sector.

Participant L commented that *“Government also needs to provide incentives if they want to see growth – other countries’ feed-in tariff is subsidised by the government.”*

This view was supported by Participant B, who commented that *“Government subsidies should be provided for installation of SSEGs especially deep in the rural areas where there are no networks.”* Participant B further suggested that *"International* *grants should be encouraged to assist in the installation of SSEGs in poor areas of the country."*

Participant D proposed the provision of *"favourable electricity tariffs."* Participant C suggested a *"Tariff reform to ensure municipalities are properly compensated for the back-up service being provided."*

Participants indicated the need for regulatory certainty and removal of the regulatory burden as important to enable the growth of the sector.

To enable a quick registration process, Participant D commented on the need for *"streamlining registration processes."* Participant B proposed the establishment of a *"Quick registration process in the form of an online registration process that is web-based."*

The introduction of the online registration process was affirmed by Participant C who commented about the need for a *"Regulatory and policy reform that is supportive of mass deployment, including a free online system to register new installations."*

Participant F proposed a *"Clear regulatory framework to enable upscaling of the SSEGs."*

Participants identified feed-in tariffs as an important incentive globally that promotes the growth of the sector. In this regard, Participant L commented that to *"Provide incentives for customers who install SSE S PV, feed-in tariffs are seen to be the most significant incentive internationally."*

Participant D proposed *"clear guidance about feed-in tariffs and fixed charges for grid access."*

Participant C suggested that *"the development of a feed-in tariff that makes it cheaper for the municipality to buy power from households or businesses than from Eskom, but still incentivises households and businesses to remain grid-connected in the interest of ensuring low-cost electricity and equity between rich and poor households."*

Effective communication has also been identified as important to promote the growth of the sector. To improve communication and public awareness, Participant B indicated the need for *"Customer education to make the public aware that there is* *enabling regulation and notices to allow the entrance of SSEGs as well as to explain the NERSA registration and licencing process."*

Participant D proposed the need for *“clear and proactive communication to inform consumers about the requirements.”* This solution was supported by Participant G who proposed the establishment of clear, open communication and better alignment and commented as follows *"I believe the rules and protocols should be clear and more effort towards fast-tracking the sector."*

Participants proposed that the increase of the registration threshold from 1MW to 10MW promotes the growth of the sector. Participant B responded that *“increasing the 1MW threshold for registration will encourage more installation of SSEGs as registration is easier than licencing.”* This suggestion is supported by Participant G, who proposed *“simpler regulation and changing 1 to 10MW to only registration and not licencing.”*

4.4 SUMMARY OF THE FINDINGS

This chapter identified the positive and negative factors affecting the growth of the SSE S PV sector in South Africa. The research findings indicate the positive factors to include the following:

- good solar irradiation or abundance of;
- sun resources;
- high electricity tariffs of both Eskom and Municipalities;
- technology, relating to the rapidly falling prices of solar PV technology;
- enabling policy and regulatory environment;
- load shedding;
- reduction of greenhouse gases; and
- incentives such as feed-in tariffs and net metering.

The research findings identified negative factors affecting growth as follows:

- intermittency of solar PV technology;
- regulatory uncertainty;
- affordability;
- lack of incentives;

- incumbency;
- revenue loss; and
- technology

The key challenges of facing the SSE S PV sector were identified to include the following:

- lack of funding;
- regulatory burden;
- Absence of back-up generation to support SSEGs,
- delay in issuing environmental permits;
- high costs;
- unattractive feed-in-tariffs for SSEGs;
- lack of clear regulatory framework and rules of engagements; and
- perception by utilities that SSEGs diminish their revenues.

The findings propose the following as solutions that can enable the growth of the SSE S PV sector:

- introduction of net-metering;
- tax incentives;
- quick registration process;
- clear regulatory framework;
- feed-in tariffs; and
- improved communication or public awareness.

CHAPTER 5: DISCUSSION OF THE FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.1 INTRODUCTION

In Chapter 4, the findings of this study were presented and described under the four identified themes. The findings were also presented using direct quotations from the participants.

This chapter discuss the research findings, conclusions as well as recommendations. The research findings are discussed in the context of the literature review as described in Chapter 2.

The objectives of this study were to identify and describe the barriers affecting growth in the SSE S PV sector in South Africa and to identify the key drivers for growth in the SSE S PV sector in South Africa.

The research findings are discussed in line with the socio-technical transition theory which is referred to as the Multi-Level Perspective (MLP), which related to the interaction at the three MLP levels of landscape, regime and niche (Geels et al., 2017; Rolffs et al., 2015b; Schot & Geels, 2007). The chapter also discuss the findings within the context of socio-technical factors, which are institutional, technical, economic and social factors as informed by literature (Sovacool et al., 2011; Sovacool & Drupady, 2011). The discussion of the findings is followed by a conclusion, which provides a summary of the findings and the recommendations.

5.2 MULTI-LEVEL PERSPECTIVE

5.2.1 The landscape level

Landscape-level is described as external changes or developments that put pressure on the regime which ultimately creates opportunities for niche technologies (Rolffs et al., 2015). In response to the question of factors affecting the growth of the SSE S PV sector, participants indicated that the need to reduce greenhouse gas emissions is playing an important role in influencing people to install solar PV systems.

Respondents further indicated that as citizens are becoming aware of global environmental issues such as global warming, they want to contribute to the solution of reducing greenhouse gas emissions by converting to renewable energy technologies such as solar PV systems. This finding confirms Rennkamp et al.'s (2017) assertion that advocates of renewable energy in South Africa relate to the benefits of economic development and reduction of emissions.

These external environmental factors are influencing change in South Africa’s energy landscape, opening opportunities for renewable energy technologies such as SSE S PV systems. Also, South Africa is amongst the 195 countries that signed the Paris agreement, committing to the reduction of greenhouse gas emissions (Boersma & VanDeveer (2016).

5.2.2 The regime level

The regime level refers to the level where the incumbent resides. This refers to South Africa's dominant utility which is Eskom. Research findings indicate that people are moving to SSE S PV systems due to the challenges Eskom is facing. These mainly include capacity constraints that have led to the country experiencing rolling power cuts as well as increasing electricity tariffs.

Respondents indicated factors such as load shedding and power shortages as factors that necessitate the installation of SSE S PV technology. One participant emphasised that power shortage and load shedding greatly contribute to citizens taking energy issues into their own hands by seeking alternative renewable energy sources.

This affirms Ockwell and Byrne's (2017) view that the key feature of the socio-technical regime involves the alignment of various trajectories such as technology, markets and users. The findings indicate that the preferred technology is changing from significant fossil fuel-based technologies to small distributed renewable energy technologies such as SSE S PV.

5.2.3 The niche level

The findings indicate that solar PV technology is gaining traction in South Africa due to good irradiation. In this regard, respondents indicated that it can be installed anywhere in the country. Participants also indicated that the decrease in costs of solar PV technology is another contributing factor for this technology to gain traction.

Also, various policies and regulations are being introduced to support the introduction of solar PV technologies. Participants indicated that the introduction of enabling regulation, such as the amendment of regulations for new generation capacity, licencing and registration notice as well as a directive to license own-use generation without an approval to deviate from the integrated resource plan contributes to the emergence of new technological innovations such as SSE S PV systems.

The above findings affirm the description of niche innovations as technical innovations that are different from the current socio-technical regime but succeed in gaining traction in specific markets with the backing of directed policy support (Geels et al., 2017; Grin et al., 2010).

The external pressures for the need to adopt renewable energy technologies to reduce greenhouse gas emissions, power shortage problems, as well as increasing electricity prices, are putting pressure on Eskom. These pressures are opening an opportunity for innovative technologies, such as SSE S PV, to gain a market share. This confirms Geels et al.'s (2016) view that socio-technical transitions emerge when internal momentum builds up at niche innovations through improvement in performance or price, momentum results in pressure exerted by external developments on the incumbent regime which results in tensions and expansion opportunities for new innovative technologies.

5.3 SOCIO-TECHNICAL FACTORS

5.3.1 Institutional factors

According to Sovacool and Drupady (2011), institutional factors relate to policy and regulatory issues. In this study, participants indicated policy and regulatory factors as affecting the growth of the SSE S PV sector in South Africa.

The findings of this study indicate institutional factors that negatively affect the growth of the sector to include regulatory uncertainty and regulatory burden. These findings support literature that identified policy and regulatory uncertainty to be among the barriers to the growth of decentralised renewable energy systems (Yaqoot et al.;,2016).

Participants indicated that the regulatory environment for the SSE S PV is difficult to navigate. According to the respondents, there are currently no clear policies for municipalities and Eskom with regards to the SSE S PV sector. Other participants further pointed out that the regulatory burden within the sector is a challenge.

According to the respondents, there is red tape on the registration process of SSE S PV systems. This finding confirmed Sovacool and Drupady's (2011) view that fragmented, incoherent energy policies and regulations affect the growth of the small renewable electricity market.

The lack of a clear pricing policy in the sector was identified as negatively affecting the growth of the sector. In particular, respondents indicated that the pricing policy where bills are based on kilowatt-hours sold with low service charges affect the growth of the sector. Respondents pointed out that this has resulted in electricity distributors, such as municipalities, being restrained in promoting rooftop solar PV technologies because they are afraid of losing electricity customers who are paying for their electricity usage. According to the respondents, this will result in these municipalities only remaining with electricity customers who are not able to pay. Markard et al. (2016) indicate that the establishment of markets and upscaling of innovative socio-technical systems is facilitated by developmental policies.

Most of the study participants indicated that putting in place a clear regulatory framework will greatly assist in scaling the SSE S PV sector in South Africa. Participants further suggested that the introduction of regulatory incentives which make financial sense will attract the installation of SSE S PV systems thereby contributing to the growth of the sector.

The factor of incumbency as it relates to the dominance of Eskom was also identified to negatively affect the growth of the sector. The study findings indicate that participants are of the view that Eskom is receiving preferential treatment from both the policy and regulation formulation.

5.3.2 Technical factors

Research findings identified intermittency of solar PV technology, grid connection and NRS standards or requirements as technical factors affecting the growth of the SSE S PV sector.

The majority of participants indicated the intermittency of solar PV technology negatively affects the growth of the sector. This is because solar PV depends on the sun and the production of electricity is affected when there is no sun. However, participants mentioned that energy storage batteries are important to address the intermittency problem. According to participants, energy storage is a good enabler for the growth of the sector. However, there is a need for certainty concerning the licencing of energy storage. Literature suggests that solar PV technology should be designed with energy storage batteries because of their non-dispatchable nature (Thopil et al., 2018).

The research findings also identified the challenges with regards to grid access as affecting the growth of the sector. Participants pointed out that the requirements or standards required to connect to the grid are very restrictive. Participants further indicated that the Energy Regulator is not independent enough to tell Eskom that they should allow unbiased access to the grid. According to Thopil et al. (2018), connecting to the grid results in a quick increase and decrease in voltage levels as a result of the intermittent nature of SSE S PV. This also results in the quality reduction of electricity and is not able to meet the required load during load shedding (Thopil et al., 2018).

Respondents indicated that the decreasing prices of solar PV technology positively contribute to the growth of the sector. Respondents stated that prices of solar PV technologies have decreased dramatically, making the technology more affordable. This finding confirms the view that reducing costs is making renewable energy technologies more economically viable than fossil fuel sources (Pérez Arriaga et al., 2017).

The rapid speed at which solar PV technology is maturing was mentioned by respondents to be contributing to growth in the sector. As an example, respondents highlighted that solar panels and inverters that were bought three years ago are now obsolete.

The other technical factors respondents identified as affecting the growth of the industry include issues of accreditation and localisation. The participants indicated that the absence of local capacity to manufacture panels and inverters instead of relying on imports affects the growth of the sector. Respondents proposed that localisation can be addressed by upskilling to enable those critical and complicated components, such as inverters, to be manufactured locally. According to respondents, local production of solar panels, for example, will contribute to reducing prices to be affordable and will enable skills development of the local youth. The finding supports

Sovacool and Drupady (2011) who identified lack of skills and inadequate training as factors that affect the development of renewable electricity systems.

5.3.3 Economic factors

The findings indicate economic factors that affect the growth of the SSE S PV sector to include affordability, incentives, and revenue loss.

Affordability is described by respondents of this study within the context of electricity consumers not able to afford to pay for their electricity consumption, mainly due to the increasing prices from both Eskom and municipalities. Respondents indicated that increasing electricity prices have resulted in electricity consumers installing SSE S PV systems in their homes, as well as in sectors such as agriculture, industrial and commercial. The majority of respondents indicated that increasing electricity tariffs positively affects the growth of the SSE S PV sector. Electricity consumers are converting to embedded generation due to the increasing cost and unreliability of electricity supply (Mkhwebane & Ntuli, 2019).

Findings further indicate that incentives or lack thereof, affect growth in the SSE S PV sector. The research findings show that the introduction of incentives such as feed-in tariffs can positively affect the growth of the industry whilst the lack of feed-in tariffs negatively affect the growth of the sector.

Participants indicated that the presence of feed-in tariffs incentivise residential and commercial electricity consumers to be grid-connected. However, findings also indicated that lack of feed-in tariffs negatively affects the growth of the industry as it limits the expansion of solar PV installations due to the inability to recover the outlay.

Respondents pointed out that the absence of feed-in tariffs or low tariffs delays or hampers the installation of solar PV systems as it would not make business sense. This finding affirms Nhamo and Ho's (2011) argument that policy on the feed-in tariff was important to encourage investment.

The other finding of the study was that some municipalities are not willing to install SSE S PV systems as they view them as potentially reducing their revenue. This is because most municipalities rely on electricity to generate their revenues.

The research findings also identified a lack of funding as a factor that affects the growth of the sector. Respondents indicated funding challenges such as limited balance sheet capacity of off-takers and suggest payment terms of funding need to be on a longer period to be able to support a lower tariff.

5.3.4 Social factors

This study identified education, communication, public awareness and funding or subsidies as social factors that affect the growth of the SSE S PV sector in South Africa.

Participants pointed out the need for customer education to create public awareness about existing enabling regulations and notices that allow the entrance of SSEGs. According to the respondents, this public awareness will also explain the Energy Regulator’s regulatory processes and requirements with regards to the registration and licencing process of SSE S PV systems. Respondents also identified a lack of communication between the electricity distributors, such as municipalities and their customers, particularly in sharing information about their willingness and readiness to accept SSE S PV systems to be connected to their grid and explaining the applicable rules.

Lack of funding was also identified as another social factor affecting the growth of the sector. Participants indicated that there is a need for government subsidies, particularly in deep rural areas, for the installation of SSEGs. Respondents also advocated for international grants to be encouraged to assist in the installation of SSEGs in poor areas of the country. High prices of renewable energy make it difficult for the general public to accept renewable energy as compared to fossil fuel energy, such as coal (Yuan et al.; 2015).

Social factors, such as funding, government subsidies and grants affect the growth of the SSE S PV sector. This affirms Carlisle et al.'s (2015) view that social factors can either facilitate or hamper the development of renewable energy projects.

5.4 SUMMARY OF DISCUSSION ON RESEARCH FINDINGS

This section provides a summary of the research findings using the socio-technical theory or MLP levels as discussed in the previous section.

The research findings confirm literature that identified socio-technical factors to include institutional, technical, economic and social factors (Sovacool et al., 2011; Sovacool & Drupady, 2011). The findings also indicate that the socio-technical factors affect growth of the sector both positively and negatively.

The findings indicate institutional factors that affect the growth of the sector to include policy and regulatory uncertainty as identified by Yaqoot et al. (2016). Respondents have indicated that policy and regulation affect growth of the sector both positively and negatively. Respondents indicated that the uncertainty with regards to policy and the regulatory environment negatively affects growth of the sector. However, respondents also identified the introduction of certain policy and regulatory issues such as the exemption of SSE S PV of up to 1MW from the licencing regime as a positive factor that facilitates growth of the sector.

The research findings also indicate that technical factors affect growth of the sector both positively and negatively. The findings show that technical factors such as the intermittency of solar PV technology, grid connection as well as required standards or requirements for connection to the grid negatively affect growth of the sector (Thopil et al., 2018). Thopil et al. (2018) further posit that it is important to introduce solar PV technology together with energy storage batteries to mitigate the intermittency of this technology. The study indicates that positive technical factors relates\ to the decreasing costs of solar PV technologies as suggested by Pérez Arriaga et al. (2017).

The economic factors that affect the growth of the sector include affordability, incentives, and revenue loss. The findings indicate that increasing electricity tariffs which result in consumers not being able to afford these prices have been identified as pushing people to consider alternative electricity generation technologies such as SSE S PV. According to Mkhwebane and Ntuli (2019), electricity consumers are changing to embedded generation because of the increasing cost and unpredictability of the electricity supply. Also, the lack or low feed-in tariffs affect the growth of the sector as feed-in tariff has been identified as important in encouraging investment in the sector (Nhamo & Ho,, 2011).

The research findings identified social factors that affect the growth of the sector to include funding, government subsidies and grants. The findings indicate that the absence of funding, within the context of the high prices of renewable energy as compared to fossil fuel, makes it difficult for consumers to accept renewable energy technology. According to Carlisle et al. (2015), social factors can either enable or impede the development of renewable energy projects.

Regarding the interaction at the three MLP levels of landscape, regime and niche (Geels et al., 2017b; Rolffs et al., 2015b; Schot & Geels, 2007), the research findings indicate that environmental factors such as the need to reduce greenhouse gas emissions in line with the Paris commitments are putting pressure on the country to introduce renewable energy technologies in the country's energy mix (Boersma & VanDeveer (2016). The need to comply with these Paris commitments, coupled with Eskom's challenges of load shedding and unreliable electricity supply at the regime level, has been identified as opening opportunities for emerging renewable technologies, such as SSE S PV at the niche level, to emerge as alternative technologies (Geels et al., 2016)

5.5 RECOMMENDATIONS

The following are recommendations which are based on the research findings. The recommendations are mainly for policy makers and regulators.

- There should be an active strategy from government and the regulator to promote SSE S PV, particularly in light of the on-going threat of load shedding and the reality that such systems present a quick and cheap method (no direct government money) for boosting energy supply.
- Solar PV is jobs-intensive and a mass deployment and thus offers significant industrialisation opportunities.
- Establishment of a collaborative unifying umbrella body to drive research and development (R & D) for the deployment or role out of the SSE S PV technology.
- Develop clear rules and regulatory frameworks.
- Introduce attracting feed-in tariffs for SSEGs
- Get rid of the perception that the SSEGs are responsible for lower revenues in utilities.
- Open up the market by allowing 1-10MW to also just register and not get a licence.
- Ensure speedy finalisation of wheeling agreements

- Shorten or streamline the regulatory process to allow more SSEGs in the country.
- Conduct customer education to enhance or create awareness of the tools available to allow entrance of SSEGs in the country.
- Introduce tax incentives.
- Ensure clarity on regulatory requirements and tariffs.
- Establish clear communication about the requirements.
- Conduct more awareness campaigns to expose the value offered by embedded small PV.
- Introduce digital platforms to support growth and development of the sector.

5.6 LIMITATIONS OF THE STUDY

The following are some of the limitations of the study:

- The COVID-19 Regulations: the lockdown regulations were a limitation for this study regarding the collection of data. The initial plan was to conduct face-to-face interviews, using a semi-structured interview guideline to collect data. However, it was not possible to conduct face-to-face interviews due to the lockdown regulations. In this regard, the researcher conducted interviews using virtual platforms, telephone, and self-completion of the interview guide by the respondents.
- The use of a qualitative research method only was another limitation of this study. The use of this research approach only has resulted in a limited number of the sample size.
- Limited budget for this study as well as the time constraints with regards to the completion of the study were other limitations. If there was availability of financial resources and time, the researcher would have considered the possibilities of targeting a larger population and sample size.

5.7 SUGGESTIONS FOR FUTURE RESEARCH

The limitations described above present an opportunity for further research. The suggestions for further research are recommended as follows:

- A further study using a quantitative research method needs to be conducted.

- The quantitative research study will determine the existence of a positive or negative relationship between the growth of the SSE S PV sector and the socio-technical factors identified by this study.
- The recommended quantitative study can also look at the broader solar PV sector and not limited to the SSE S PV sector. This would also increase the population size for the study.

6.8 CONCLUDING REMARKS

This study was set to identify and describe the barriers affecting growth in the SSE S PV sector in South Africa, as well as to identify the key drivers for growth in the SSE S PV sector in South Africa. The above objectives were achieved by utilising the socio-technical theory or multi-level perspective approach. The findings confirm that socio-technical factors of institutional, technical, economic, and social factors affect growth of the SSE S PV sector. The findings further confirm that the interaction at the three MLP levels of landscape, regime and niche are exerting pressure for the introduction of emerging renewable technologies, such as SSE S PV, into the country's energy mix.

The growth of the SSE S PV sector is critical and is urgently required to address the electricity supply challenges in South Africa. The recommendations of this study, which are informed by the findings, should be seriously considered, and addressed by the relevant policy and regulatory authorities. This will assist to facilitate growth of the sector, the majority of the findings indicate that factors that negatively affect growth of the SSE S PV sector mainly relates to policy and regulatory issues.

It is important for academics to consider the recommendation for a quantitative study on SSE S PV sector to be conducted. The further study will assist in quantitatively investigating the identified socio-technical factors, as well as developing a model.

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ANNEXURE A: INTERVIEW GUIDE

Perceptions on factors affecting growth in the small-scale embedded solar PV sector in South Africa

1. What would you say are the factors that affect the growth of the small-scale embedded solar PV sector in South Africa?

2. How would you describe or in which manner are these factors affecting the growth of the small-scale embedded solar PV sector in South Africa?

3. What would you suggest as solutions to enable growth in the small scale embedded solar PV sector in South Africa?

4. What are the factors that you perceive can drive the growth of small scale embedded solar PV sector in South Africa?

5. What would you describe as challenges or obstacles facing the small scale embedded solar PV sector in South Africa?

6. What suggestions or improvements that can be made to enable growth in the small scale embedded solar PV sector in South Africa?

To complement the above six questions, follow-up and clarification questions will be asked to prompt reflection when necessary.

The above interview questions for this study were structured in line with interview questions in studies conducted by several authors (Ford et al., 2017; Sovacool & Drupady, 2011; Zhao et al., 2016). Zhao et al. (2016) formulated the interview questions for the participants to comment on the obstacles they perceive to be prohibiting the growth of wind power in China. Ford et al. (2017) structured the interview questions in such a manner to assist in identifying the main factors involved in the adoption of solar PV in New Zealand. Sovacool and Drupady (2011) designed their interview questions to facilitate the identification of the main challenges for the small renewable power industry in Malaysia.

APPENDIX B: ETHICS INFORMATION SHEET

Dear Sir / Madam,

My name is Charles Hlebela and I am a Masters student in the Energy Leadership Centre at the University of the Witwatersrand, Johannesburg. As part of my studies, I have to undertake a research project and am investigating perceptions of the factors affecting growth in the small-scale embedded solar photovoltaic (SSE S PV) sector in South Africa under the supervision of Dr Freddy Mgiba. This research project aims to identify and describe perceptions of factors affecting growth in the SSE S PV sector in South Africa.

As part of this project, I would like to invite you to take part in an interview. This activity will involve answering semi-structured questions and will take around 45 minutes. With your permission, I would also like to record the interview using a digital device.

There will be no personal costs to you if you participate in this project. You will not receive any direct benefits from participation but there are no disadvantages or penalties if you do not choose to participate or if you withdraw from the study. You may withdraw at any time or not answer any question if you do not want to. The interview will be completely confidential and anonymous as I will not be asking for your name or any identifying information. The information you give to me will be held securely and not disclosed to anyone else. I will be using a pseudonym to represent your participation in my final research report. If you experience any distress or discomfort at any point in this process, we will stop the interview or resume another time.

If you have any questions during or afterwards about this research, feel free to contact me on the details listed below. This study will be written up as a research report. If you wish to receive a summary of this report, I will be happy to send it to you. The data collected from this research project will be stored in the computer which is password protected and will be kept for five years. With your permission, the data collected from this research project may be used by other researchers. If you have any concerns or complaints regarding the ethical procedures of this study, you are welcome to contact the University Human Research Ethics Committee (Non-Medical), telephone +27(0) 11 717 1408, email hrec-medical.researchoffice@wits.ac.za

Yours sincerely,

Charles Hlebela
Email: 8609052m@students.wits.ac.za
Mobile: 0836468280
Supervisor:
Dr Freddy Mgiba

APPENDIX C: ETHICS CLEARANCE CERTIFICATE

UNIVERSITY OF THE
WITWATERSRAND,
JOHANNESBURG

SCHOOL OF GRADUATE SCHOOL OF BUSINESS ADMINISTRATION ETHICS COMMITTEE CONSTITUTED UNDER THE UNIVERSITY HUMAN RESEARCH ETHICS COMMITTEE (NON-MEDICAL)

CLEARANCE CERTIFICATE **PROTOCOL NUMBER: WBS/BA8609052M/454**

PROJECT TITLE	Perceptions of factors affecting growth in the Small-Scale Embedded Solar Photovoltaic sector in South Africa
INVESTIGATOR	Mr Meddas Charles Hlebela
SCHOOL/DEPARTMENT OF INVESTIGATOR	MM (Energy Leadership)
DATE CONSIDERED	11 September 2020
DECISION OF THE COMMITTEE	Approved unconditionally
RISK LEVEL	MINIMAL RISK
EXPIRY DATE	30 JUNE 2021

ISSUE DATE OF CERTIFICATE 23 September 2020 **CHAIRPERSON** ______________
(Dr MDJ Matshabaphala)

cc: Supervisor: Dr Mgiba

DECLARATION OF INVESTIGATOR

To be completed in duplicate and **ONE COPY** returned to the Chairperson of the School/Department ethics committee.

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

Signature ______________ **Date** 28/09/2020