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Small-scale embedded generation in South Africa

Implications for energy sector transformation from a local government perspective

Anna Filipova and Mike Morris

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Southern Africa –Towards Inclusive Economic Development (SA-TIED)

The SA-TIED programme looks at ways to support policy-making for inclusive growth and economic transformation in the southern Africa region, through original research conceived and produced in collaboration between United Nations University World Institute for Development Economics Research (UNU-WIDER), National Treasury, International Food Policy Research Institute (IFPRI), and many other governmental and research organizations in South Africa and its sub-region. A key aspect of the programme is to encourage networking and discussion amongst people involved in policy processes across the participating organizations and civil society aiming to bridge the gap between research and policy-making.

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ABSTRACT

The falling cost of renewable energy technologies globally is a key driver of the implementation of small-scale embedded generation in South Africa as an alternative to electricity from the national grid. The technology has disruptive potential for the vertically integrated and centralised electricity value chain, dominated by Eskom. It challenges the structure and governance of the value chain from the local level up, creating conflicts and potential benefits for key stakeholders. A coherent policy approach, rooted in the understanding of the co-benefits, is key in managing and planning the scale-up of this technology at the local government level.

Keywords: mixed methods, disruptive technology, energy politics, value chains, governance, South Africa

JEL codes: L94, O33, P48, Q42

1 INTRODUCTION: ENERGY SECTOR TRANSFORMATIONS AND THE ROLE OF SMALL-SCALE EMBEDDED GENERATION

The rise of renewable energy globally was until recently driven by commitments to tackle climate change through the implementation of clean energy technologies. The 2015 Paris Agreement created significant momentum for the scale-up of clean energy generation technologies, as it aimed to stimulate policies which would restrict the global rise in temperature, caused by human impact, to below 2 °C (UNFCCC 2015). As a result of the Agreement, renewable energy considerations featured prominently in national policies, including the signatory countries' nationally determined contributions and national development plans. The global community has clearly recognized and voiced support for the urgency to increase the adoption of renewable energy (RE) technologies as a climate change mitigation measure (Hermanus 2017; IEA 2016; Riahi 2015; UNECA 2016; UNFCCC 2015). These national objectives have until recently been implemented through incentive mechanisms, such as subsidized feed-in tariffs (FITs) and auctions, which made RE more attractive for private sector investors. Such policies were largely successful in creating an enabling environment, leading to a boom in the global demand for RE technologies. As a result, the cost of solar photovoltaic (PV) technologies has reached record lows, based on prices coming out of 2017 RE auctions: USD 0.032/kWh in Mexico and USD 0.024/kWh in Abu Dhabi (IRENA 2018). The global weighted average levelized cost of electricity[1] (LCOE) for utility-scale solar PV decreased by 73% since 2010, reaching a record low of USD 0.10/kWh, based on projects commissioned in 2017 (IRENA 2018).

As one of the signatories to the Paris Agreement and the world's fourteenth largest emitter of CO2 (Global Carbon Atlas 2015), South Africa has made a commitment to diversify its energy mix by adding more than 20 GW of RE (NPC 2013), amounting to 40% of its current total generation capacity. Parallel to such policy commitments, South Africa suffered two severe supply crises in the period between 2007 and 2015, which became a key driver of the creation of the RE auction programme: the Renewable Energy Independent Power Producer Procurement Programme (REI4P) (Morris and Martin 2015). Deemed, until recently, 'one of the world's most successful and best-governed renewable energy procurement programmes' (Eberhard and Naude 2017: 3), it added 2.15 GW of RE to the energy mix, and led to wind and solar becoming the cheapest new-build generation option, at an LCOE of ZAR 0.62/kWh, compared to ZAR 1.03/kWh for electricity produced by baseload coal and a projected cost of new nuclear of ZAR 1.09 /kWh (Wright et al. 2017). The REI4P had significant implications for the cost of RE technologies and was the first mechanism which allowed competition to enter the electricity value chain (VC), creating entry points for small-scale RE projects, such as small-scale embedded generation (SSEG) to enter the generation space.

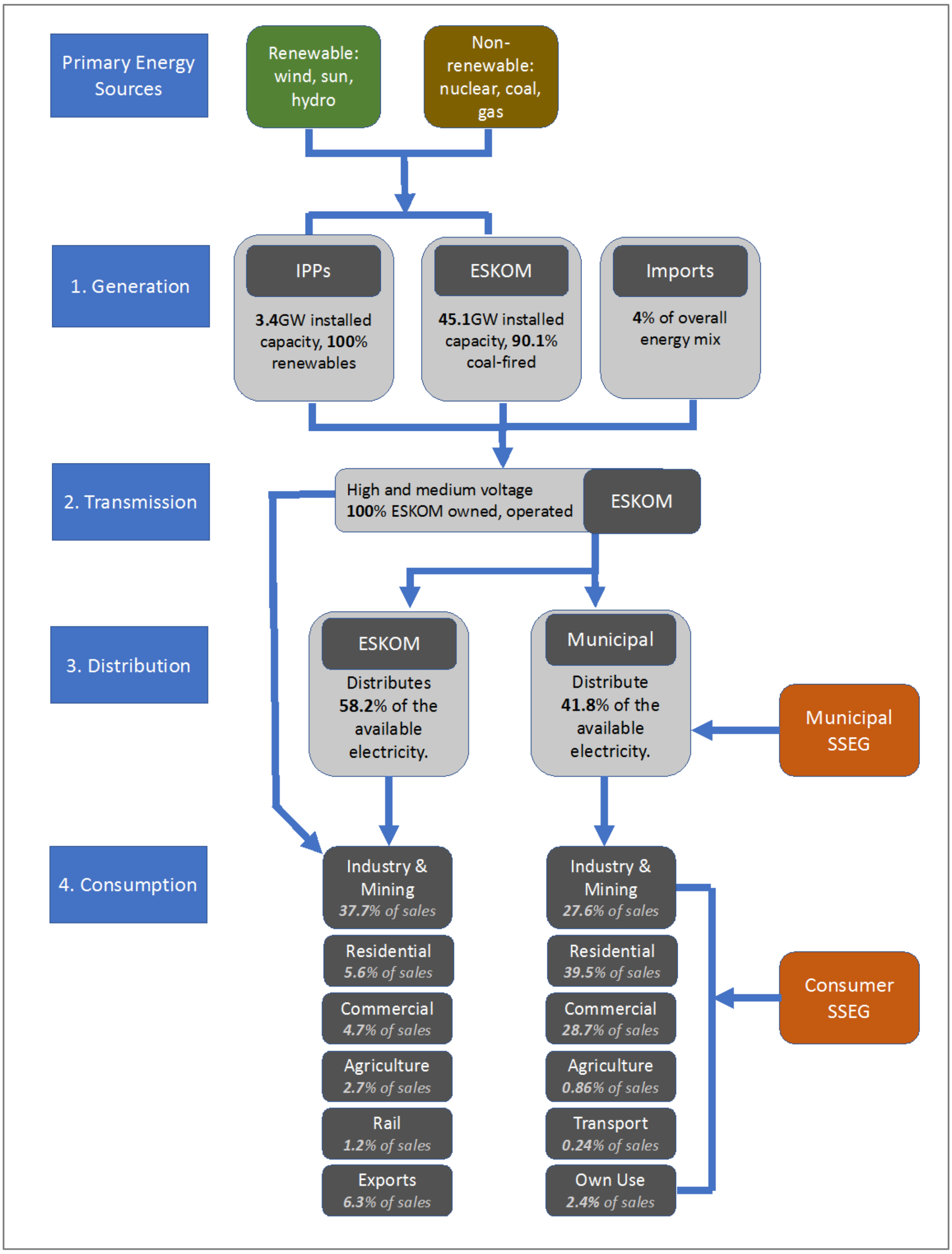
SSEG is part of a global trend towards decentralization of electricity generation. Internationally the phenomenon is known as distributed generation, signifying that the generator is situated at the point of consumption of electricity, rather than centralized, as power generation has been historically in the electricity VC. This form of electricity generation is increasingly seen as a solution to electrification issues in sub-Saharan Africa, where 30–40% of the population on average is rural (Turkson and Wohlgemuth 2001). For the purpose of this study, SSEG is understood as an electricity generation system with an installed capacity of less than 1 MWp,[2] which is connected to the national grid, with the purpose of using the grid as a back-up system and feeding electricity back into the grid at a predetermined FIT. SEEG creates significant implications for actors and stakeholders along the VC via two main channels: i) it lowers the demand for

1 LCOE is formed by the total fixed and variable costs of any generator of electricity and is a widely used metric in comparing the relative costs of different generation technologies.

2 The definition is based on a November 2017 amendment (Licensing Exemption and Registration Notice) to the Electricity Regulation Act of 2006, which allowed for systems of up to 1 MWp to be installed and connected to the grid without the need for a section 34 ministerial determination for a generation licence (DoE 2017a).

electricity; and ii) it allows new players to enter the electricity generation space by utilising decentralized small-scale renewable energy technologies. SSEG therefore has the potential to become a disruptive force in the context of a highly vertically integrated electricity VC (Figure 1).

Figure 1. South Africa's electricity value chain with small-scale embedded generation



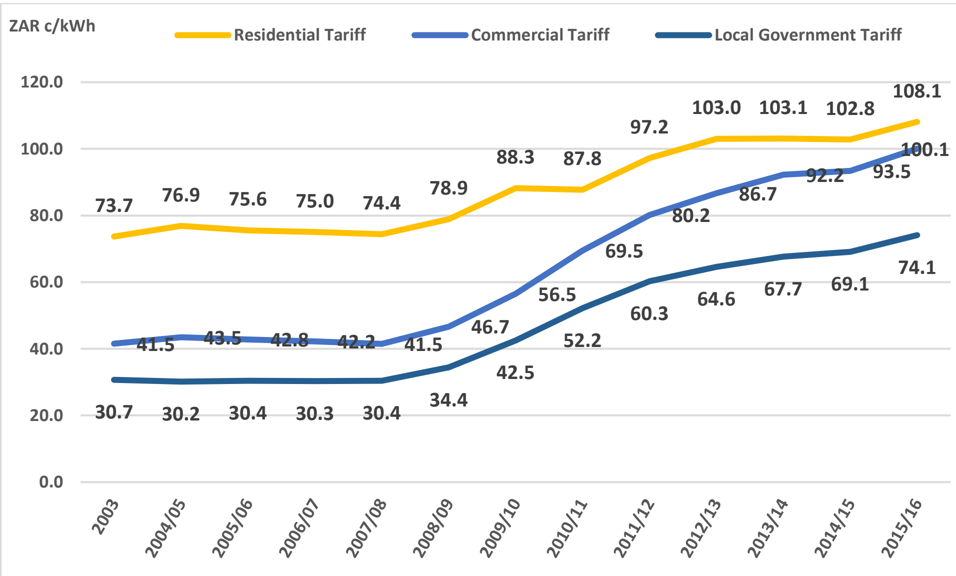
Data sources: DoE (2017b); Eskom (2017b); NERSA (2012)

The South African energy sector has historically been highly politicized and is characterized by a highly vertically integrated electricity VC, which is dominated by the national electricity utility, Eskom. The electricity sector's historical importance in terms of the country's industrialization and economic development have made it a valuable token on the political agenda, creating huge vested interests for the key actors. This has contributed both towards solidifying the concentration of its governance in the hands of the central government through its largest state-owned enterprise and towards its path dependency on widely available resources for electricity generation, such as coal. SSEG is a disruptive force for this status quo.

As seen from Figure 1, Eskom holds significant rents in electricity generation, distribution and transmission along the VC, resulting in significant power over the governance of the VC and ability to prevent competition. Municipalities are responsible for less than half of the electricity being distributed, with Eskom supplying 58.2% of electricity to consumers in 2016, while electricity is a significant source of revenue for municipalities, with 35% of total revenue on average being derived from electricity. Electricity consumers play a critical role in determining the demand for electricity and have been negatively affected by the trend of rising electricity tariffs and load-shedding due to supply constraints. In this context, SSEG enters the VC at the points of the consumer and municipal distributor and changes the power dynamics in the VC by allowing consumers and municipalities to generate electricity. It therefore has important implications for the mandate of municipalities. This is why municipalities were selected as the focal point for investigating the implications of SSEG for the structure of the South African energy sector.

Between 2003 and 2015-16, Eskom's residential tariff increased by 47% in real terms, while the tariffs to commercial consumers and local government (electricity distributors) increased by 141% in real terms (Figure 2). The rising cost of electricity has, therefore, been one of the key drivers of SSEG implementation both by municipalities and consumers.

Figure 2. Eskom tariff increases in real terms (2015 prices)



Source: Eskom (2017a)

SSEG is an opportunity for municipalities to tap into the function of electricity generation and sell their own electricity to consumers instead of purchasing it from Eskom. The South African Constitution of 1996 mandates municipalities with the right and authority to administer electricity distribution within their area of jurisdiction, subject to national and provincial regulation. In reality, electricity distribution is divided between Eskom and municipalities, each responsible for supplying electricity to about half of electricity consumers in the country. At the same time, municipalities have local development plans and policies, which increasingly incorporate climate change issues and deal with mitigation and adaptation strategies, a significant part of which is the implementation of RE projects. In addition, municipalities are key actors in meeting the government's socioeconomic objectives at the local level through providing access to affordable electricity services, among others. SSEG presents itself as an opportunity for municipalities to fulfil these mandates despite any misalignments between national- and local-level agendas.

In the absence of an overarching policy clarifying and guiding the approach of the national government towards SSEG, many questions remain, creating a grey area for SSEG systems to thrive in. Despite the lack of clarity in terms of national level regulation of SSEG, municipalities have been allowing systems up to 1 MWp within a framework of local level rules or processes. This in turn has disrupted and introduced new dynamics into the historical structure of the energy sector in South Africa.

1.1 Theoretical framework

According to the disruptive technological innovation theory (Christensen 1997; Christensen and Bowen 1996), the behaviour of traditional well-established actors towards a disruptive technology becomes key in determining the implications. While some traditional actors along the VC would be willing to change their way of doing business by incorporating the disruptive technology in a way that is beneficial to them, other actors might suffer the consequences of path dependence, as they become locked into traditional business models (Christensen 1997; Christensen 2004; Christensen and Bowen 1996). Christensen (1997) observed that large incumbent firms are primarily guided by the demands of their existing customers and markets. However, that leaves them vulnerable to missing out on the needs of new customers, as they are dismissive to new technologies which fail to address their existing customer's needs. This weakness of the well-established firm results directly from its path-dependency (Kaplinsky 2017). In recent years this has been highlighted by the literature on disruptive innovation, including, with regards to the electricity production industry, Green and Newman (2016), Kind (2013), Schleicher-Tappeser (2012) and Tayal (2016).

It is in view of this context that the study's approach to combining the three conceptual frameworks – disruptive innovation, VCs framework, and a political economy analysis – becomes useful. It is the key to analysing how the disruptive force of SSEG is affecting actors and stakeholders along the electricity VC. This is critical for identifying which actors are likely to attempt to drive or obstruct the spread of the disruptive technology as they become winners or losers, respectively, from this process. This, in turn, will help identify possible policy measures, as well as entry points for unlocking national level support for SSEG in the context of a highly centralized energy sector. The findings from an analysis which combines the VC framework approach with a political economy approach is useful for policy making, especially with regards to the highly politicized energy sector. This is so because it helps to identify areas of policy intervention, where cooperation or communication can be fostered between the key stakeholders, who drive or obstruct the process, and it could therefore lead to a successful transformation (Morris and Martin 2015; Schmitz 2015, 2016, 2017; Schmitz et al. 2013).

1.2 Research design

The main goal of this study is to understand the implications of SSEG for the structure of the electricity VC, its governance, and its overall future sustainability. To this end, the study will analyse the key drivers and obstacles for implementing SSEG, as well as the most important implications for the key actors in the electricity VC. The study will analyse these implications by looking specifically at the case of municipalities. The implications of SSEG are most clearly visible at the local government level, given the complex mandate of municipalities to support local economic growth through the provision of reliable and affordable electricity services while also playing a key role in driving the climate change response agenda. The implications – threats and benefits – are analysed based on the data generated through a mixed methods research approach. Qualitative data through key stakeholder interviews (detailed in Annex I) and quantitative data through surveys were collected and integrated in this analysis, in order to triangulate, contextualize and reinforce the findings. In some places this was augmented by secondary data from sources identified by respondents, as a way to close the gaps of information in some of their responses. Based on the data collected, a comparative analysis is conducted of four metropolitan municipalities (metros): Cape Town, Johannesburg, eThekwini and Ekurhuleni.

2 IMPLICATIONS OF SSEG THROUGH THE PERSPECTIVE OF METROPOLITAN MUNICIPALITIES

This section is an excerpt from the key findings of the study. For a complete section on key findings from the study, please refer to Filipova and Morris (2018).

2.1 Rules, regulations and tariffs

SSEG is currently not regulated at the national level, despite ongoing attempts of the Department of Energy (DoE) and the National Energy Regulator of South Africa (NERSA) to develop overarching regulatory rules. In the grey area created by the absence of a coherent national regulatory framework, metros have developed local level mechanisms, procedures and associated tariffs, for connecting SSEG to the distribution network, which vary across cities. These rules vary across the different municipalities but generally involve an application process with a strong focus on the technical compliance of the systems, including requirements for the meter which measures how much electricity is fed back into the grid. One of the most important conditions in these rules is the net-consumer requirement: customers who have an SSEG system connected to the municipal grid are expected to consume more electricity on an annual basis than they feed in (Interview: Sullivan3). This is done in order to minimize the threat to municipal revenue.

It was also understood through the interview process, that in order to avoid too big a gap between SSEG rules and requirements in different municipalities, a working group was established, including all metros and the South African Local Government Association (SALGA), which developed a set of template documents and forms, based on documents initially developed by the City of Cape Town, with support from GreenCape. These documents were endorsed by the Association of Municipal Electricity Utilities (AMEU) and have been published on their website so that they can be adapted by all municipalities who wish to develop SSEG procedures. Apart from assisting municipalities in dealing with SSEG systems, this is expected to contribute to a more harmonized approach across South African municipalities in the absence of a national level regulatory framework. NERSA has also been involved in the process in order to ensure that the template documents align with the national SSEG rules which they are currently finalizing.

Table 1. Rules, regulations and tariffs per municipality

Metropolitan municipality	SSEG Rules	FIT	Value of FIT (c/kWh)	Net FIT	Fixed fees	Value fixed fee (ZAR/month)
Cape Town	Yes	Yes	Commercial & residential: 68.89	No	Yes	342.9 (ZAR 11.43 /day)
Johannesburg	Yes	Yes	Commercial: 39.7 Residential: 42.5	No	Yes	1-phase: 229.23 3-phase: 331.11
eThekwini	Yes	Yes	Commercial & residential: 68.29	Yes	Yes	Dependent on tariff.
Ekurhuleni	No	No	N/A	No	No	No
Overall	75% Yes	75% Yes	Average: 54.85	75% No	75% Yes	Average: ZAR 301.08

Source: Filipova and Morris (2018)

3 All key stakeholder interviews were conducted in 2017 and will be referenced as above: ‘(Interview: Last name of interviewee)’. A complete list of key stakeholders interviewed can be found in Annex I.

FITs are the key dis/incentivizing instrument which is currently available to municipalities, especially with regards to stimulating the private sector to get involved in SSEG implementation (Interview: City of Johannesburg Focus Group Discussion). In addition to FITs, which are based on the amount of electricity that is fed into the grid, municipalities charge SSEG systems fixed network charges, which are meant to help them cover grid maintenance costs. Fixed tariffs are the key mechanism which metros can use to protect their decreasing revenues due to lower electricity sales (Interviews: Vermeulen, Bowen).

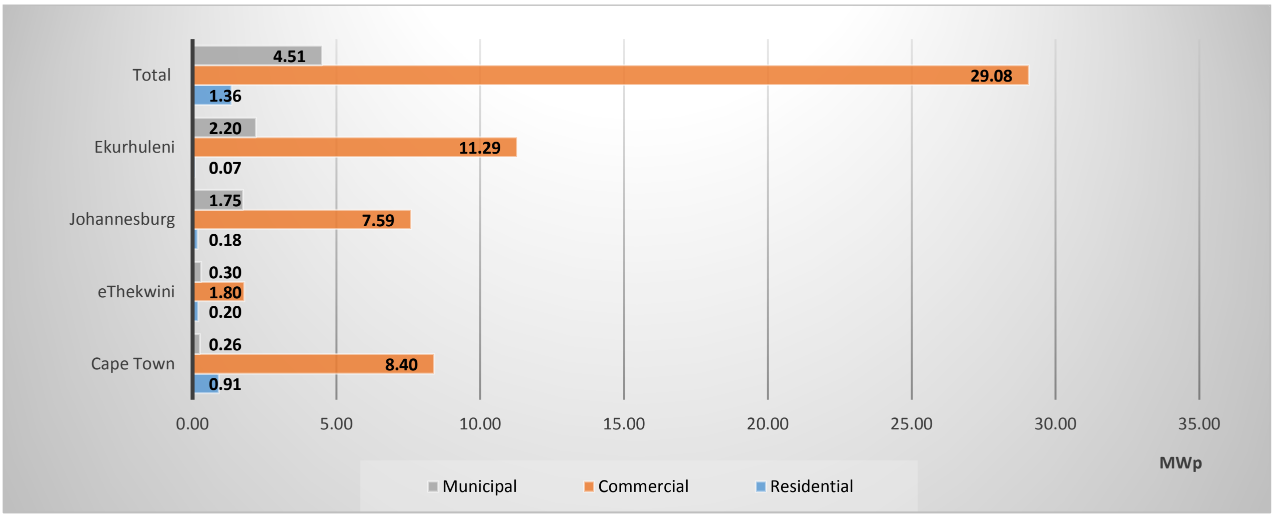
Out of the metros surveyed, three had FITs in place, approved by NERSA, with Ekurhuleni in the process of developing these. Cape Town was the first city to have a NERSA-approved FIT and as such was considered a pilot city (Interview: Ward). Cape Town and Johannesburg both have net billing tariffs in place. eThekwini submitted an application for FIT to NERSA in 2011/12 and they did not get it approved until very recently. In the interval before the FIT was approved, people were building SSEG and feeding into the grid without getting reimbursed for it (Interview: Naidoo). eThekwini is the only municipality among the surveyed ones which has a net metering FIT, which developed with support from the Council for Scientific and Industrial Research (CSIR), and which it is currently piloting. While this option is more attractive to SSEG installers, as it offers a higher FIT level, it is more likely to have negative implications for municipal revenue. As will be seem from the section on installed generation capacity, the lack of a FIT in Ekurhuleni has not stopped consumers from implementing SSEG projects.

Tariffs in Johannesburg are quite low, at ZARc 39.7/kWh for commercial consumers and ZARc 42.5/kWh for residential consumers, compared to average rates of ZARc 118.3/kWh for residential and ZARc 173.71/kWh for commercial consumers. They are also low compared to FITs for small PV systems in other countries: in Germany the FIT was just below EURc 15/kWh (approx. ZAR 149/kWh) in 2013 (IRENA, 2015). However, South Africa in general and Johannesburg specifically get a lot more sunshine hours during the day than does Germany, so the return on investment is close to twice as high (Interview: Vermeulen) and allows for lower tariffs. What is more, this level of FIT allows for municipalities to buy electricity at a lower rate than what they get from Eskom and make a higher profit (Interview: Vermeulen). As such, SSEG becomes an alternative, cheaper source of electricity for municipalities.

2.2 Installed capacity of SSEG

The four metros have a total legally installed SSEG capacity of 38.46MWp. This amounts to an insignificant share (0.08%) of South Africa's total generation capacity. The distribution of this total capacity between metros and between the three types of systems – residential, commercial and municipal – is seen in Figure 3.

Figure 3. Legally installed SSEG capacity



Source: Filipova and Morris (2018)

With a total of 29.08MWp, commercial systems have a significant lead (75.6%) in terms of total installed capacity. Ekurhuleni metro reported the highest installed capacity of commercial SSEG systems, followed by Cape Town and Johannesburg. This information comes under question, given that Ekurhuleni does not currently have an official application process in place through which to track this capacity. Cape Town reported the highest capacity of residential systems, with 0.91MWp. Currently, municipal systems are a relatively small share at 11.7% of total installed SSEG capacity at all four metros, with Ekurhuleni reporting the highest generation capacity at 2.2MWp.

Metros obtain data on legally installed capacity through their application and commissioning process records, as prescribed by NERSA in the Draft SSEG Rules of 2015. However, not all SSEG systems comply with these procedures and currently there are no consequences for such non-compliance, leaving municipalities to deal with this issue through their bylaws. As a consequence, metros have observed a significant amount of illegally installed systems. While it has not been possible to precisely determine this amount, some metros have made estimates. The City of Cape Town estimates, from samples of aerial photo surveys, that there are many more illegal than legal systems on the territory of the municipality (Interview: Ward). GreenCape (2017) estimates that in the Western Cape there are 27.5 MWp of actual installed capacity, out of which only 7.8 MWp has been approved through an application process. Johannesburg estimates anywhere between 1.4 MWp and 22 MWp illegally installed capacity, based on feedback about sales from technology suppliers and installers in the region.

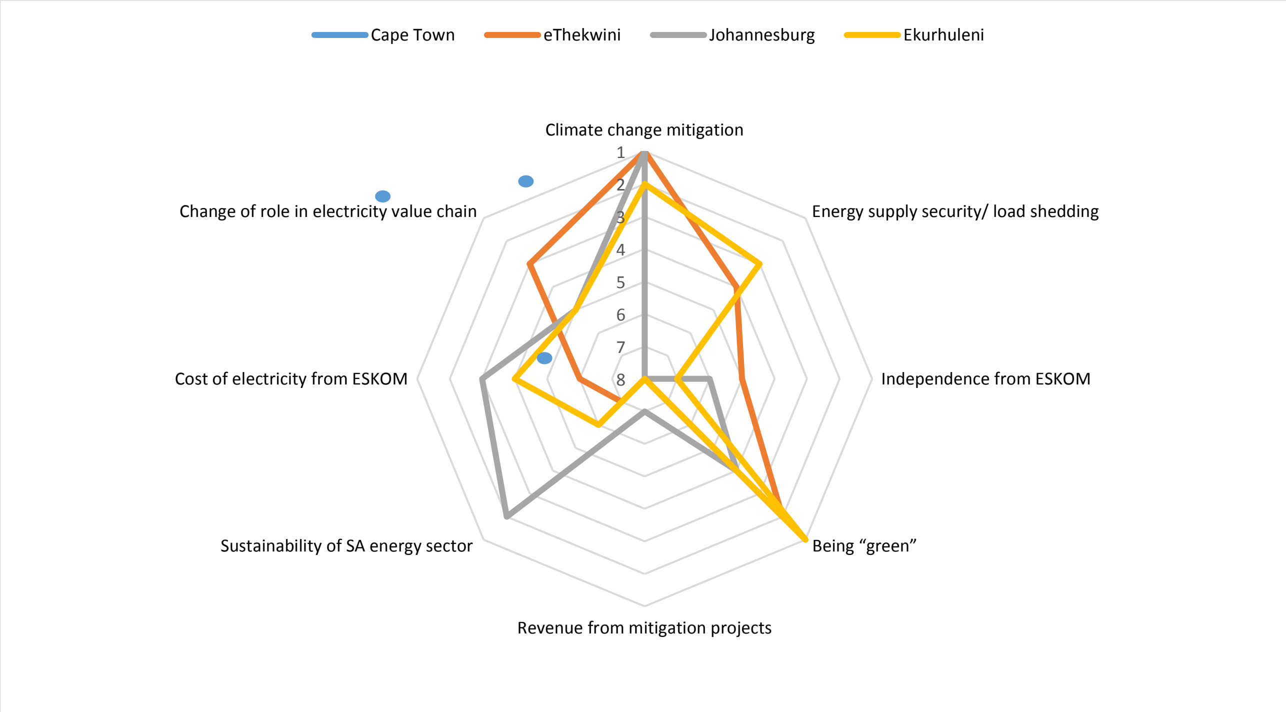
2.3 Drivers and obstacles for SSEG implementation

Drivers of SSEG for municipalities

An important focus of this study was to identify the main drivers for municipalities to implement their own SSEG projects. As shown in Figure 4, based on survey responses, climate change mitigation objectives were clearly identified as the most important driver, with three out of four metros (Cape Town, Johannesburg, eThekwini) ranking it as the most important and one (Ekurhuleni) ranking it as second most important, after the importance of being perceived as ‘green’. Being ‘green’ was also ranked as the second most important driver by eThekwini. These results confirm a strong imperative for municipalities to play a role in achieving South Africa’s climate change mitigation commitments, which was detected during stakeholder interviews. (Interviews: Johannesburg Focus Group Discussion, Ntshalintshali). The cost of electricity, which was ranked third most important by Johannesburg and fourth most important by Ekurhuleni, emerged during interviews as an important driver, as some stakeholders saw SSEG as a solution to their being able to provide more affordable electricity services (and more reliable, with Ekurhuleni ranking security of supply as the third most important driver) in the future as Eskom electricity tariffs are expected to continue to rise.

The sustainability of the energy sector in this survey was understood as the sector’s future resilience in the context of the current structure and governance of the electricity industry. Many interviewees expressed a view that the current model of electricity supply management is not sustainable (Interviews: Naidoo, Sewchurran, Vermeulen). The sustainability driver was ranked as the second most important by Johannesburg metro. During the interview process, it became clear that the future sustainability and relevance of electricity distribution services, and therefore of the entire energy sector in South Africa, has come under threat by the combination of rising electricity tariffs and unreliable grid services. Based on the interview at City Power Johannesburg it is clear that they perceive SSEG as an opportunity and taking measures to remain relevant as a service provider as a critical factor for its own and the energy sector’s future sustainability (Interview: Vermeulen).

Figure 4. Importance of various drivers of SSEG for ***municipalities***[4]



Source: Filipova and Morris (2018)

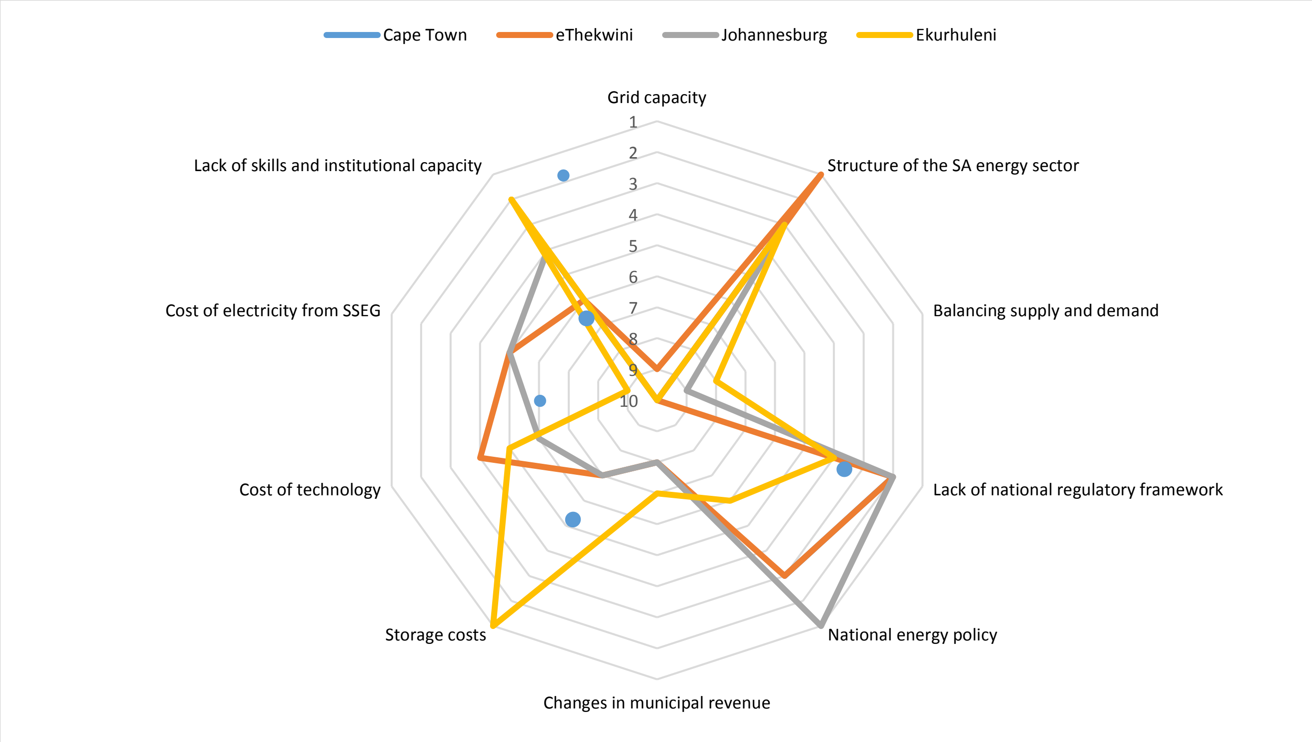
Obstacles for municipalities

As seen in Figure 5, the number one obstacle in the way of municipalities implementing SSEG systems more widely was reported to be the current structure of the South African energy sector – ranked first out of ten factors by Cape Town and eThekwini, and third by Ekurhuleni and Johannesburg. As discussed during stakeholder interviews, this obstacle refers to the highly vertically integrated structure of the electricity sector, where Eskom exercises its power over generation, transmission and distribution, leaving municipalities little choice in terms of the cost and sources of the electricity they are responsible for distributing to consumers. Specifically, stakeholders are concerned that Eskom has significant control over the grid (Interview: Eberhard) and as such it has the power to decide and prevent SSEG systems from connecting to the grid (Interview: NtshaliNtshali).

The next obstacle, which ranks similarly in terms of importance is the lack of a national level regulatory framework for SSEG, as ranked second by eThekwini, Cape Town and Johannesburg. More specifically, under the current version of Section 34 of the Electricity Regulation Act (2006), new generation capacity is only allowed into the system after special determination by the minister of energy. This section, as discussed earlier, was recently updated to make exceptions for installations under 1 MWp. This exception was approved after the interview and survey process for this study was already completed so responses do not take this into account. The NERSA SSEG rules, which are currently in the process of being finalized are considered to be very progressive in their approach to regulating SSEG (Interview: Bowen).

4 Cape Town provided only partial responses to some of the questions in this section. That is why their spider graphs are incomplete and only show the ranking for some of the suggested drivers as dots.

Figure 5. Importance of various obstacles for SSEG for municipalities[5]



Source: Filipova and Morris (2018)

Also in this category, and third in terms of overall importance according to the four respondent metros, is the obstacle of the general national level policy, which is characterized by a focus on large-scale, centralized energy projects (Interviews: Sullivan, Hilton). Given the disruptive potential of SSEG, as well as the fact that institutional capacity usually falls behind the rate of technological change (Interview: Jones), it is important that these obstacles are prioritized.

The cost of solar PV and storage technologies, and therefore the electricity generated from SSEG systems, features as an obstacle for municipalities, albeit a less important one. Similarly, this obstacle has the prospect of becoming less important as technology costs continue to decline. Two factors that came out during interviews are the issues around the capacity of the grid to accommodate additional RE systems, as well as the difficulty of balancing supply and demand with increasing amounts of variable RE sources coming online (Interview: Sewchurran). A recent report commissioned by Eskom and DoE, which concluded that the South African grid is capable of adapting to very large amounts of variable RE (GIZ 2017), supports the view of some of the interviewees that these factors are only an obstacle in light of a limited skills and institutional capacity (Interviews: Sullivan, Jones).

The capacity obstacle, which was ranked second by Ekurhuleni, fourth by Johannesburg and sixth by eThekwini, out of a total of ten obstacles, seems to be the main reason behind the struggle of municipalities, especially smaller ones, to deal with the technical issues arising from increasing levels of SSEG on the grid. While some metros may have the technical skills required to do so, they have operated for a long time in a traditional centralized energy planning system, which renders them inexperienced to deal with the implications of decentralized energy generation (Interviews: Jones, NtshaliNtshali). However, smaller metros and municipalities are significantly under-resourced, to the point where they struggle to ‘keep the lights on’ and manage their day-to-day operations, and therefore lack the capacity to deal with such implications

5 Cape Town provided only partial responses to some of the questions in this section. That is why their spider graphs are incomplete and only show the ranking for some of the suggested drivers as partial lines or dots.

(Interviews: Jones, NtshaliNtshali). Some of the metros also reported being under-resourced to deal with SSEG: Ekurhuleni Energy Department, for example, are capacitated at only 20%, with a total of three people working in their alternative and RE unit (Interview: Ekurhuleni Focus Group Discussion).

Given that SSEG negatively affects electricity sales, which is where a significant portion of municipal revenue comes from in South Africa, implications for revenue become one of the ten key obstacles for SSEG implementation by municipalities. This obstacle ranks low , however, with an average score of around eight out of ten, as metros stated during interviews that solutions are being developed in collaboration with CSIR, SALGA, AMEU, or are already available and being applied (Interviews: Vermeulen, Naidoo). The revenue implications are discussed in more detail in section 2.4. below.

2.4 Implications of SSEG

One of the main channels through which SSEG affects municipalities is by reducing the overall demand for electricity. The implications of this are analysed in this section.

Electricity consumption and municipal revenue

It was estimated that the electricity generated by SSEG systems is insignificant (less than 0.2%) as a share of the total electricity consumption (sales). Despite this, three of the four metros reported that municipal revenue streams are negatively affected or are expected to be negatively affected as penetration rates increase. It was determined through the surveys that a significant portion – 35% on average – of revenue in the four metros is derived from the sale of electricity. A significant portion of this revenue currently goes to Eskom for the purchase of bulk electricity. The remainder is distributed across other municipal activities, such as operational expenses, grid maintenance, provision of other basic services, such as water (Interview: Sewchurran). The high dependence on revenue from electricity is exacerbated by the cross-subsidization issue (Interview: Naidoo): the fact that revenue from electricity is used to subsidize other basic services as well as revenue from high-income electricity consumers being used to subsidize low-income consumers. NERSA considers this issue a top priority and sees itself as the key actor needing to ensure that low-income customers without access to SSEG systems and relying on grid electricity will be protected in some way from the progressively increasing tariffs (Interview: NERSA Focus Group Discussion).

Cross-subsidization is a key issue in the context of SSEG for two main reasons. First, municipal electricity tariffs for high-income, high-consumption users are inflated in order to generate revenue for low-income users. While this is a necessary progressive economic policy in the context of South Africa's persisting poverty and inequality, it pushes up electricity costs and incentivizes high-income users to look for alternatives, such as SSEG. Second, it clearly defeats the purpose of cross-subsidization, when SSEG is an option for high-income consumers, as they will be the first to defect the grid (Interview: Naidoo) and revenues will drop significantly as a result, leading to decreasing opportunities for cross-subsidization of low-income consumers. Similarly, municipalities will have less revenue to subsidize other basic services delivery.

The co-benefits

From the perspective of municipalities, SSEG systems are RE projects, which help reduce CO2 emissions and therefore have direct climate change mitigation benefits. At the same time, SSEG projects also potentially have co-benefits in terms of job and local content creation opportunities. They also have the potential to stimulate actions which enhance the future resilience of municipalities in the context of rising electricity costs and falling electricity sales. It is important to note that all REI4P projects had specific socioeconomic development targets (their effectiveness often being debated and currently under investigation as part of a DoE commissioned study), incorporated into each power purchase agreement. There is currently no such mechanism in place for SSEG projects. Therefore, their socioeconomic benefits are often (if at all) monitored on an ad-hoc basis. Respondents to this question from three metros – eThekwini, Johannesburg and Ekurhuleni – stated that they believe there are co-benefits from SSEG projects. All respondents felt that measuring these co-benefits is important and two of the four metros (Cape Town and Johannesburg) reported that they have a framework in place for measuring them. Johannesburg has an understanding that measuring the adaptation co-benefits is important because it helps make the case for climate change projects by showing socioeconomic outcomes which are more relatable in a development context than CO2 emissions (Interview: Johannesburg Focus Group Discussion). At the same time, in Johannesburg metro's understanding, this approach is useful in explaining how the 'so-called' revenue losses could be offset by other economic benefits, such as job creation and local content (Interview: Johannesburg Focus Group Discussion).

The electricity value chain

SSEG has significant implications for a highly centralized and vertically integrated electricity VC, such as the one in South Africa. The national grid, similarly to other traditional centralized energy systems globally, has not been designed to accommodate distributed renewable sources of electricity. Such decentralized generation solutions entirely change the energy profile of the system, making it more difficult to manage (Interview: Sewchurran). While there are technical solutions to such obstacles, municipalities may struggle to deal with them due to capacity constraints. At a national level, Eskom is becoming concerned that, if SSEG implementation continues to increase, it can cause significant reductions in electricity sales as well as grid defection by high-income customers. At the same time, there seems to be a focus on large-scale projects, instead of finding solutions for decentralization of generation. SSEG storage and access to financing for small-scale decentralized solutions have the potential to completely disrupt the way the energy sector is structured (Interview: Trollip).

Some stakeholders expressed views that, even though SSEG gives municipalities the opportunity to produce their own electricity, they will still be dependent on Eskom and the grid when the sun doesn't shine and as long as storage is too expensive (Interview: Salvoldi). Others felt that municipalities should be allowed to have generation licences as well, as long as these allow them to generate electricity which is cheaper than what they can buy from Eskom (Interview: Vermeulen). Another option for municipalities to get access to cheaper, cleaner electricity is through getting into power purchase agreements (PPAs) with local independent power producers (IPPs). IPPs have approached metros (Cape Town and eThekwini) in order to try and agree these, but metros are not currently clear whether they are legally allowed to do this (Interview: Ntshalintshali). PPAs become problematic for municipalities due to the provisions of the MFA which make it difficult for them to get involved in long-term contracts (given that PPAs with RE IPPs are usually 20-year contracts) (Interview: NERSA Focus Group Discussion).

Despite these issues, all respondents to the survey stated that they see a need and an opportunity for a change of the role of municipalities in the electricity VC through SSEG. SSEG provides municipalities with the opportunity to break away from Eskom's dominance over the VC and generate their own electricity, choosing a cleaner energy mix than the one currently supplied by Eskom. At the same time, it provides them with the opportunity to draw from a pool of co-benefits at the local level and therefore stimulate local economic development. The lack of a national regulatory framework for SSEG implementation, as well as the current structure of the energy sector, is one of the main obstacles in the way of municipalities taking advantage of this opportunity.

Given this fact, metros were asked to identify, which actors would be in support and which would be against SSEG in the context of a possible change of the role of municipalities in the VC. From Table 2, it becomes clear that metros see SSEG as a cross-cutting issue which would need to be discussed not only among local government representatives, but in a group of stakeholders from various government departments. National Treasury (NT) is clearly identified as one the key stakeholders, given the municipal revenue implications of SSEG. The Department of Trade and Industry (DTI) would also play a part according to some of the metros, possibly in relation to maximising the economic co-benefits, as discussed earlier. At the same time, metros feel that it is important to involve the private sector and civil society in the conversation as key stakeholders.

Table 2. Coalitions of power in SSEG discussions

Metropolitan municipality	Stakeholders	In support of SSEG	Against SSEG
Cape Town	NT, Eskom, NERSA, DoE, Metros, SALGA, NGOs, universities, energy field	-	Eskom, DoE, NERSA
eThekwini	NERSA, DoE, DTI, NT, solar associations, municipalities, transmission and distribution operators	Solar associations	Some municipalities and distribution operators
Johannesburg	DoE, Ministry of Cooperative Governance & Traditional Affairs, NT, Department of Public Enterprises (DPE), all national departments, citizens, AMEU, SALGA, Private sector in RE, RE associations, DoE, Department of Labour (DoL), Department of Environmental Affairs (DEA), Engineering Council of South Africa	NT, DoE, Department of Science and Technology, DTI, AMEU, SALGA, private sector, RE associations	DPE, DoE, DoL, DEA, Eskom
Ekurhuleni	Municipalities, NT, NERSA, DTI, DoE, Eskom for initial conversations, systems installers, commercial/residential consumers, SALGA	Municipalities, NT, NERSA, DoE, Systems Installers	Eskom, maybe NT

Source: Filipova and Morris (2018)

Metros see potential support for a change in the role of municipalities through SSEG mainly coming from private sector entities and associations from the RE sector. From a political economy perspective, this seems like a logical possibility, given that these stakeholders could be the biggest enablers and winners from the job creation and local content co-benefits, associated with SSEG. Similarly, DTI is expected to be in support, provided that they are able to maximize on the economic development implications of SSEG. Given that, based on the survey results, metros see SSEG as an opportunity rather than as a threat to their mandates, municipalities and local government associations are expected to be in support, with small exceptions. Possibly, given the capacity constraints faced by some municipalities, their support will depend on the degree to which they are able to deal with the issues and maximize the benefits, as well as the support they are provided through this process.

Eskom and DPE have clearly been identified by metros as stakeholders against the rise of SSEG. In the context of the current structure of the energy sector, it is clear these two entities have a lot at stake. They stand to lose revenue from electricity sales, as well as control over the generation function of the VC. Stakeholders from the metros clearly understood the need to involve Eskom in their processes and planning concerning SSEG in order to ensure that the process is sustainable (Interview: Ntshalintshali). There is little cooperation currently between the different levels of government in trying to find solutions to these conflicts. Based on the results presented in the table, the roles of Treasury, NERSA and DoE in this discussion are debatable. DoE's position on SSEG, however, is made conspicuous by its absence from the 2016-17 Draft Integrated Resource Plan (Interview: Petrie). Interestingly, the decisions about implementing the policy recommendations made hereafter, lie within Treasury, NERSA and DoE.

3 CONCLUSIONS AND RECOMMENDATIONS

The findings from this study suggest that SSEG has the potential to become a significant disruptive force for the structure of the South African energy sector as its rates of implementation intensify and approach a tipping point in terms of affordability. SSEG is a disruptive force, because it is nearing a point where its adoption is mainly driven by its economic and technical viability. SSEG has far-reaching implications for actors and stakeholders in terms of electricity sales, revenue streams and their role in the electricity VC. This is especially evident in the case of municipalities. Despite these implications, municipalities do not see SSEG as a threat but, rather, as an opportunity. Metros clearly recognize that SSEG has the potential to drive positive change with regards to making their operations and service delivery models more sustainable and resilient.

While it is clear that SSEG could negatively affect municipal revenue in its current structure, it also creates an opportunity for municipalities to become more sustainable in the context of a changing energy sector. There is an opportunity for municipalities to diversify their revenue streams by engaging with SSEG generation. Electricity consumption in South Africa is expected to decrease under the pressure of a variety of factors, such as lower economic growth, energy efficiency and decentralized generation, and municipalities could benefit from rethinking their municipal revenue models, their dependence on electricity consumption as a source of revenue as well as their role in the electricity VC. This can increase their future resilience and sustainability and can also ensure they are able to provide quality and affordable services to consumers. This is especially critical in a context where the triple challenges of poverty, inequality and unemployment persist and ever-rising Eskom electricity tariffs threaten to exacerbate these.

With regard to the climate change mitigation mandate of municipalities, SSEG allows them to choose how much clean energy they can generate or buy and distribute, while in the traditionally centralized system Eskom had full control over power generation, with municipalities being forced to buy bulk electricity, 90% of which is produced by coal-fired power plants. At the same time, it allows municipalities to offer consumers more affordable and secure electricity services in the future, instead of depending on Eskom for 100% of their electricity, which comes at ever higher costs each year. In addition, SSEG projects have potential co-benefits in terms of job creation, local content opportunities and resilience, which are have not been properly quantified and are likely currently not being maximized. Quantifying the co-benefits from SSEG and coming up with recommendation on how these can be maximized are identified as areas of future research.

SSEG creates some threats but also provides opportunities, sometimes placing local government at odds with national entities, in the context of an electricity VC, which has historically been controlled by a monopolistic state-owned entity. In the case of emerging disruptive technologies, regulatory and legal frameworks often lag behind adoption rates. Therefore, it is highly recommended the actions detailed below are taken urgently to accommodate the rising force of SSEG at both the local and national government level. In the context of a path-dependent and highly politicized energy sector, characterized by a vertically integrated electricity VC, measures which ensure the maximization and quantification of co-benefits are a critical factor for unlocking national level support and driving the establishment of a coherent national regulatory framework and proactive approach towards SSEG implementation.

At the same time, by defining SSEG as a disruptive technology, this study aimed to stress the fact that its implementation is likely to continue even if such frameworks are lacking, but its adverse impacts and implications for traditional electricity utilities would be impossible to predict and prevent if illegal installations continue to prevail over registered ones. It is, therefore, in the interest of sustainability of the energy sector that these frameworks are agreed on and established in due course. From a political economy perspective, there is clearly a coalition at the national level against the development of SSEG projects.

However, there is an opportunity to form a coalition in support of SSEG at the local government level, which can be driven by municipalities, which clearly see the benefits of such projects. In order to achieve this, municipalities need to mobilize support by actors and stakeholders at the national level as well. Whether SSEG contributes to a sustainable energy sector in South Africa ultimately depends on building coalitions at the municipal and national level to pursue common interests, outline co-benefits, counter path dependent contrary arguments, and mobilize support for the more rapid adoption of a formalized and regulated system.

3.1 Local-level measures

Municipalities clearly recognize that there is a set of measures which need to be taken, at both local and national levels, in order to ensure that the disruptive force of SSEG is transformed from a threat to an opportunity.

Changing the municipal business model

Municipalities can use SSEG to diversify their revenue streams in three possible ways. First, they can purchase cheaper electricity (than what Eskom provides) from consumer SSEG systems, which are connected to the grid. Second, they can generate their own electricity through municipal SSEG systems, which will also come at an increasingly lower cost. Third, they can take advantage of the rising SSEG implementation by high-income consumers and change their tariff structure to increase the revenue they receive from fixed grid connection charged as opposed to electricity consumption tariffs. This diversification will ensure that municipalities are able to continue to deliver affordable services to low-income consumers. Municipalities could, therefore, strengthen their position into the electricity generation and grid operation space and, by changing the structure of electricity tariffs for high-income, high-volume consumers to focus more on fixed and less on variable costs, they could generate revenue through grid provision, rather than electricity sales. Through implementing SSEG projects at the municipal level, specifically tackling the areas with remaining unelectrified informal settlements, municipalities could further their objectives with regards to providing access to clean and quality, affordability energy, even to the most vulnerable population groups. Unlocking the possibility for municipalities to generate their own electricity through SSEG systems is key to this aspect and requires significant shifts in the degree of current national level support.

Measuring and maximizing the co-benefits

It was overwhelmingly clear that SSEG projects have co-benefits, such as job creation and local content opportunities, in addition to an opportunity for ensuring future sustainability and resilience. Few metros, and (it can be assumed) even fewer smaller municipalities have mechanisms in place to track and measure these co-benefits. There are also no specific mechanisms in place to ensure that the potential co-benefits are maximized to their full potential to stimulate local economic development. Creating such mechanisms and measures is a critical step towards unlocking these opportunities and ensuring national government support, especially in the context of a highly politicized energy sector. This is an important area of future research, as a robust evidence base has the potential to significantly contribute to mobilizing government, civil society and the private sector in support for SSEG.

3.2 National-level support

All the local government measures discussed above are feasible for municipalities, but contingent upon national-level agreement and support for implementing them. The current lack of national level support for SSEG implementation at the municipal level is glaring. There is a lack of an overarching regulatory framework to guide and coordinate the process. There is also no consideration of decentralized energy related measures, as implemented or planned at the local government level, into national energy policy, with the Draft 2016 IRP being only one example. The main reason for this is that national-level energy policy is currently designed to support the traditional, centralized and highly vertically integrated structure of the electricity VC, with Eskom being the stakeholder with the highest degree of influence over decision making processes. Clearly, SSEG is a threat to Eskom's monopolistic hold over electricity generation and its dominance over electricity distribution. From Eskom's perspective, municipalities should not be allowed to generate their own electricity because that allows for competition in electricity generation and offers consumers alternative services which are cheaper and more reliable than the ever-more expensive electricity generated by Eskom.

The structure of the electricity value chain and the governance of the energy sector as a whole are not sustainable in their current form and could benefit from a proactive approach to decentralized measures, such as SSEG. Given the significant amount of illegally installed SSEG systems, it would be wiser to create a framework for managing SSEG implementation, rather than to simply ignore or try to obstruct its disruptive force. There is an urgent need for national government to redefine its approach to SSEG and develop a clear regulatory framework. Part of this process would include implementing the NERSA draft regulatory rules, in order to ensure that there is a coordinated and harmonized approach of SSEG implementation across municipalities. Another important aspect is for government to identify and remove the gaps and contradictions within the existing legal framework, which currently cause confusion and obstruct the implementation of SSEG.

Ensuring the sustainability of the energy sector

SSEG offers municipalities and, therefore by way of logic, the South African government as a whole, opportunities for improving access and affordability of electricity services. It also has the potential to improve overall energy security in a context of recent electricity shortages and load-shedding and continuously increasing electricity tariffs. The transition toward a decentralized energy model where clean and affordable energy is generated and distributed at the local level is therefore relevant to the country's climate action, energy security and local economic development objectives. However, in the context of a traditional centralized energy model and a vertically integrated electricity VC, currently dominated by Eskom, this transition is being obstructed by the lack of national-level support. In order for the industry to survive, and make SSEG a solution and not a threat, national government will need to rethink its entire regulatory regime and operating model, as well as the structure of the electricity VC. Specifically, a proactive approach to SSEG would require rethinking of the role of Eskom, where its monopolistic control over electricity generation and transmission is broken up and opportunities from a greater variety of sources, including larger-scale SSEG (over 1 MWp) are enabled.

Ultimately, how fast SSEG progresses depends on the political economy factors at play and whether stronger coalitions can be marshalled and mobilized in support of this disruptive innovation at the local level. The coalition resisting change in the energy power terrain is, however, much more fragile than it has been in the past. The politics cementing its policy regime are susceptible to disruption and SSEG as a disruptive innovation can play a major role to create a more sustainable energy future.

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ANNEX I – STAKEHOLDER INTERVIEWS

	Name	Position	Institution	Email	Date of interview
1	Daniel Sullivan	Strategic Support Analyst, Strategic Policy Unit, Office of the Executive Mayor	City of Cape Town Metropolitan Municipality	daniel.sullivan@capetown.gov.za	16 January 2017
2	Sarah Ward	Head, Energy and Climate Change, Sustainable Energy Department, Energy Directorate	City of Cape Town Metropolitan Municipality	sarah.ward@capetown.gov.za	16 January 2017
3	Brian Jones	Head, Green Energy, Electricity Services	City of Cape Town Metropolitan Municipality	Brian.Jones@capetown.gov.za	23 January 2017
4	Focus Group Discussion: Tshilidsi Thenga, Jabulile Kgomo, Innocent Mulaudzi, April Dlamini, Freddie Aucamp, Is'haaq Akoon	Energy Services Department and Environmental Strategy and Planning	City of Ekurhuleni Metropolitan Municipality	Tshilidzi.Thenga@ekurhuleni.gov.za	18 January 2017
5	Focus Group Discussion: Lebo Molefe, Mzukisi Gwata, Given, Thabo Mahlatsi	Air Quality, Climate Change and Energy Department, Programme Manager: Climate Change Adaptation, Programme Manager: Climate Change Mitigation, Director: Energy Directorate	City of Johannesburg Metropolitan Municipality	LeboMol@joburg.org.za	18 January 2017
6	Paul Vermeulen	Manager SCADA and Load Management, City Power	City of Johannesburg Metropolitan Municipality	paulv@citypower.co.za	14 June 2017
7	Magash Naidoo	Project Management, Energy Office	City of eThekwini Metropolitan Municipality	Magash.Naidoo@durban.gov.za	6 February 2017
8	Sbu Ntshalintshali	Renewable Energy, Energy Office	City of eThekwini Metropolitan Municipality	Sbu.Ntshalintshali@durban.gov.za	8 February 2017
9	Itumeleng Masenya	Climate Change, Energy Office	City of eThekwini Metropolitan Municipality	Itumeleng.Masenya@durban.gov.za	8 February 2017
10	Sanjeeth Sewchurran	Network Planning, Electricity Unit	City of eThekwini Metropolitan Municipality	SewchurranSan@elec.durban.gov.za	7 February 2017
11	Mlibo Bantwini	Executive: Cargo and Agrizone	Dube Tradeport	Mlibo.Bantwini@dubetradeport.co.za	7 February 2017

	Name	Position	Institution	Email	Date of interview
12	Focus Group Discussion: Reitumetse Molotsoane, Rabelani Tshikalanke	Climate Change Flagship Programmes	Department of Environmental Affairs	RTshikalanke@environment.gov.za	31 August 2016
13	Matt Rich	Property Manager	Black River Park	MattR@redefine.co.za	13 March 2017
14	Prof Anton Eberhard	Management of Infrastructure Reform Programme	Graduate School of Business, UCT	anton.eberhard@gsb.uct.ac.za	9 May 2017
15	Keith Bowen	Power Systems Economist	Eskom	karen.vreenen@eskom.co.za	12 June 2017
16	Focus Group Discussion: Andile Gxasheka, Moefi Moroeng	Renewable Energy Specialist & Specialist: Electricity wholesale trading, Electricity Regulatory Reform Department	NERSA	Andile.Gxasheka@nersa.org.za Moefi.Moroeng@nersa.org.za	13 June 2017
17	Shirley Salvoldi	Corporate Specialist, Electricity Pricing, Customer Services	Eskom	SalvolSD@eskom.co.za	12 June 2017
18	Belynda Petrie	Chief Executive Officer, Energy Expert	OneWorld Sustainable Investments	belynda@oneworldgroup.co.za	15 June 2017
19	Hilton Trollip	Senior Researcher in the Energy, Environment and Climate Change Research Group	Energy Research Centre, UCT	hilton.trollip@uct.ac.za	24 May 2017

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