10 Questions municipal officials should be asking about the document titled 'Guidelines for Small Scale Embedded Generation in Western Cape Municipalities'

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Introduction

Heightened environmental awareness, dramatic increases in the price of electricity, rapidly decreasing costs of renewable energy resources and loadshedding have all resulted in greatly increased demand for small scale embedded generation (SSEG[1]) systems.

The purpose of this document is to build stakeholder capacity within the electricity value chain by providing municipal officials with relevant guidance regarding the municipal SSEG tariffs and regulations. Information that follows is structured as a set of 10 questions relevant to the municipal SSEG rules and regulations: *Guidelines for Small Scale Embedded Generation Guidelines in Western Cape Municipalities*. Each question intends to cover a key aspect of SSEG implementation within the municipal distributor environment.

The document covers the following questions:

- What is SSEG and Solar PV and why are rules and regulations necessary?
- What are the basic elements in a PV system?
- What is the difference between grid-feed-in systems, grid-limited systems and off-grid systems?
- What are typical system costs and what trends are these costs following?
- What tariff can a customer expect and why is it designed in this way?
- What is the PV application process and who is eligible to apply?
- What information is required in the application form and why is it required?
- What are the relevant standards and regulations in terms of SSEG in South Africa?
- What by-laws should the Municipality have in place?

[1] In the context of this document, this term is used both to mean Small Scale Embedded Generation and or Generator and is mainly focused on Solar Photovoltaic systems.

1. What is SSEG and Solar PV and why are rules and regulations necessary?

This section is meant to provide information on the definition of SSEG and Solar PV as used in the context of this resource pack. The section also provides a brief explanation of what PV can and cannot achieve for a PV customer and highlights why municipal rules and regulations for SSEG are necessary.

Small scale embedded generation

SSEG refers to renewable power generation under 1MW, located on residential, commercial or industrial sites where electricity is also consumed. SSEG systems are connected to the wiring on the customer's premises which is in turn connected to, and supplied by, the municipal electrical grid – that is why these generators are considered to be 'embedded' in the municipal electrical grid.

Most of the electricity generated by a SSEG customer is consumed directly at the site. At certain points, generation may exceed consumption, and a limited amount of power is allowed to flow into the municipal electrical grid. One of the major advantages of such a municipal electrical grid-connected system, is obviating the need for backup batteries which stand-alone/off-grid renewable energy generators require.

Solar Photovoltaic

Solar PV mounted on the roof of a residential, commercial or industrial building is an SSEG installation that converts solar energy into usable electricity. Global irradiation has the potential to meet all of our energy demands. A 6 km x 6 km area of PV could potentially generate 36 GW_p of usable power which is the peak demand of South Africa[2].

The growth in installation of PV has demonstrated the potential role this technology can play in the South African electricity generation mix. This upward trend is driven by decreasing PV costs (as a result of technology improvements, economies of scale and the related learning curve), rising Eskom prices, the availability of preferential feed-in-tariffs or other financial incentives, environmental awareness and energy security concerns.

The size of residential or commercial PVs system can vary widely, from under a kilowatt in a residential home, to hundreds of kilowatts installed on a commercial building[3]. The size of the system is dependent on the intended use of the system, size of the building, the energy demand and consumption pattern (load profile), the availability of funding and the willingness of the municipal electrical grid operator to allow the system to feed back into the municipal electrical grid. It is important to note that PV is not an all-encompassing solution to the current energy crisis. Table 1 describes what a PV system can and cannot achieve for a customer.

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[2] It is important to note that PV is non-despatchable and that there is a misalignment between peak PV generation (midday) and average peak demand (early morning and late evening).

[3] This document is designed to develop the knowledge pertaining to the document titled *Small Scale Embedded Generation Guidelines in Western Cape Municipalities. This guideline only* applies to customers who wish to connect a SSEG system, with generation capacity smaller than 1 MVA (1000 kVA).

Table 1: What PV can and cannot achieve for a customer

PV does:	PV does not:
Provide price security for customer.	Stop loadshedding
Provide electricity supply security for customer.	Reduce peak demand. PV is non-despatchable – there is a misalignment between peak PV generation (midday) and average peak demand (early morning and late evening)[4].
Provide additional supply in supply constrained areas.	Protect against rising cost of peak-time energy[5].
Promote changes in the customer load profile thus adding options for other energy security options.	
Support Eskom with room for maintenance by removing some of the demand on their systems.	
Add diversity to the South African energy mix	

Why are rules and regulations necessary?

SSEG installations need to be regulated for the general benefit and protection of citizens and to ensure the manageability of the municipal electrical grid.

The parallel connection of any generator to the municipal electrical grid has numerous implications for the local electricity utility. The most pressing are:

- the safety of the utility staff
- the safety of the public and the user/owner of the generator
- technical stability of the municipal electrical grid.

Further implications include the impact of the physical presence of the generation on neighbours (e.g. visual, noise), the impact on the quality of the local electrical supply, and metering and billing issues.

[4] Unless the system is installed with storage.
[5] Unless the system is installed with storage.

2. What are the basic elements in a PV system?

This section is meant to provide information on the basic elements that make up a typical PV system. A complete PV system consists of the physical equipment and the additional resources to install and maintain the equipment.

Table 2: PV system components

Equipment	Resources
▪ The Solar Panels/modules	▪ A company to install the system.
▪ Roof mounting structures	▪ Periodic cleaning of the panels.
▪ Special Electrical Cabling	▪ A meter management solution (Municipality) to track energy consumption and generation
▪ An Inverter[6]	
▪ A meter to measure the energy generated (this is a municipal requirement, and only needed for municipal electrical grid connected systems)	
▪ Optional battery storage	

System layout

The layout and configuration of systems can differ, depending on the use of the system, size of the building, the energy demand and consumption pattern (load profile) and the willingness of the municipal electrical grid operator to allow the system to feed back onto the municipal electrical grid.

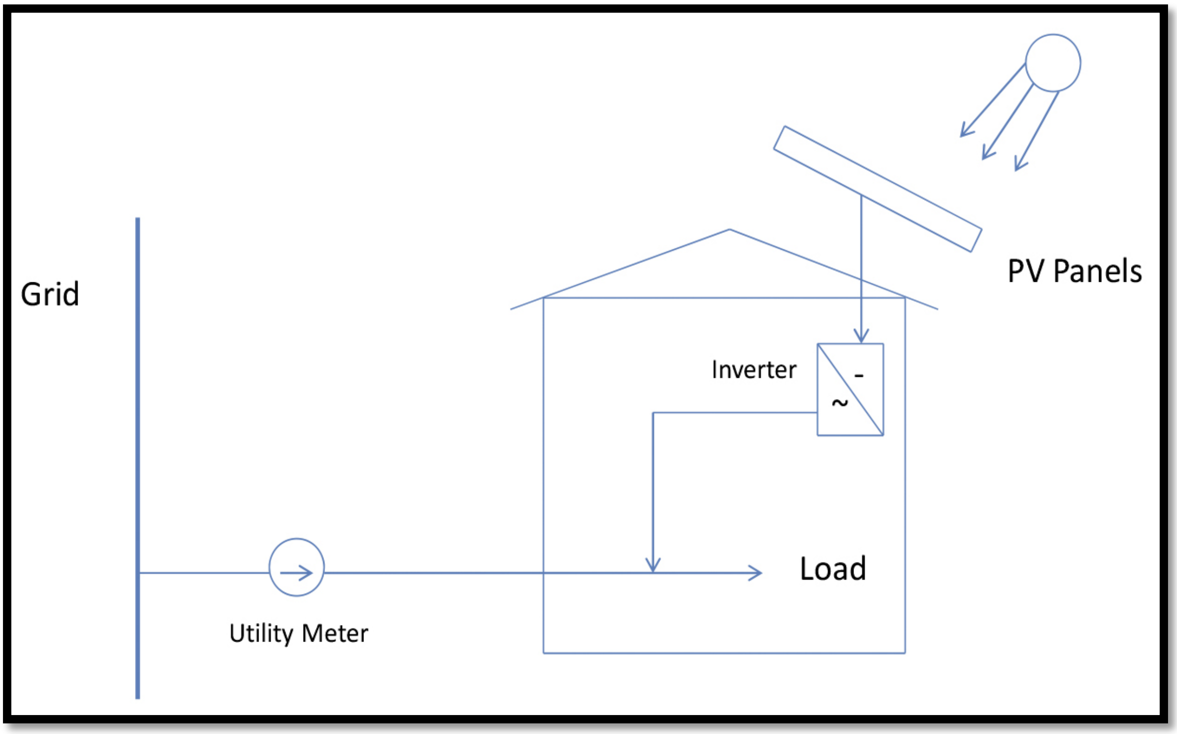

Figure 1: Indicative PV system layout

[6] A power device that converts direct current to alternating current at a voltage and frequency which enables the generator to be connected to the municipal electrical grid.

3. What is the difference between grid-feed-in systems, grid-limited systems and off-grid systems?

This section is meant to provide information on different PV system configurations in relation to the municipal electrical grid. PV systems can be connected to a customer's household using number of configurations. Each setup has its own use case and accommodates to a particular installation environment.

SSEG system that is grid-tied without reverse flow protection

A SSEG installation that is connected to the municipal electrical grid either directly or through a customer's internal wiring is said to be "grid-tied". The export of energy onto the municipal electrical grid is possible when generation exceeds consumption at any point in time and there is no reverse flow[7] protection installed.

SSEG system that is grid-tied with reverse flow protection

As with the previous system, this is an SSEG installation that is connected to the municipal electrical grid – either directly or through a customer's internal wiring. However a device is installed which prevents power flowing from the embedded generator back onto the municipal electrical grid.

Off-grid SSEG system

A SSEG system that is not in any way connected to the municipal electrical grid. Export of energy into the municipal electrical grid by the generator is therefore not possible.

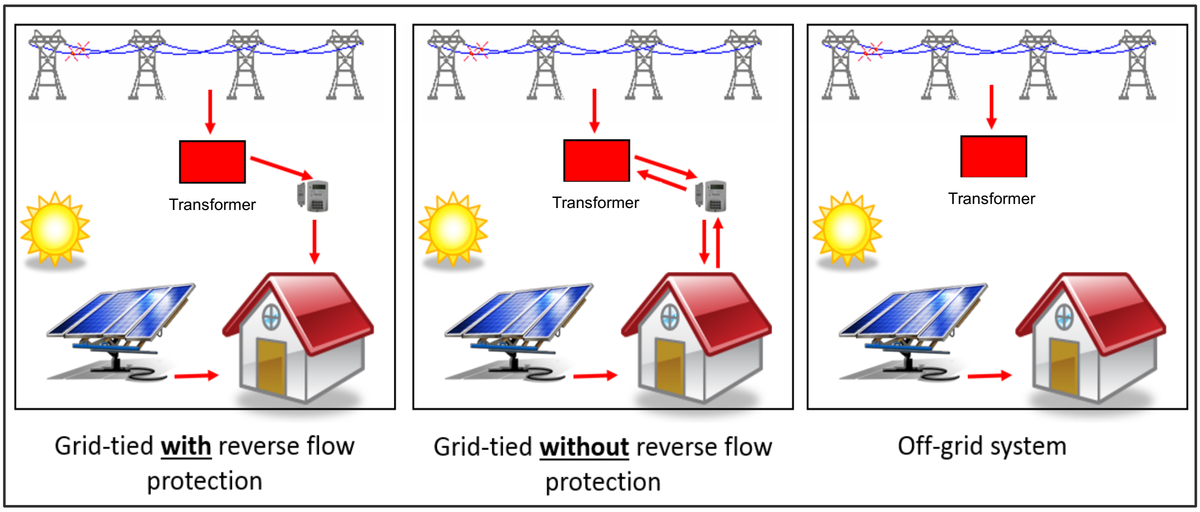

Figure 2: The difference between grid-feed-in, grid-limited and off-grid PV systems

[7] The flow of energy from the customer electricity installation onto the municipal electrical grid (i.e. export) as a result of the instantaneous generation exceeding the instantaneous consumption at the generation site in question.

4. What are typical system costs and what trends are these costs following?

This section is meant to provide information on current PV cost trends, including capital costs (and capital cost breakdown), per kWh costs (Levelised costs of energy) and municipal electrical grid party estimates.

Technical advances, upward trending demand and economies of scale have driven (and will continue to drive) reduced PV system costs. According to data collected by GreenCape, from numerous industry players, smaller systems (<10kWp[8]) have experienced an approximate 40% drop in prices over the past 3 years (2013-2016). For larger systems (>100kWp) there has been an approximate 15% drop from 2013 to 2016. This trend is expected to continue somewhat going forward[9].

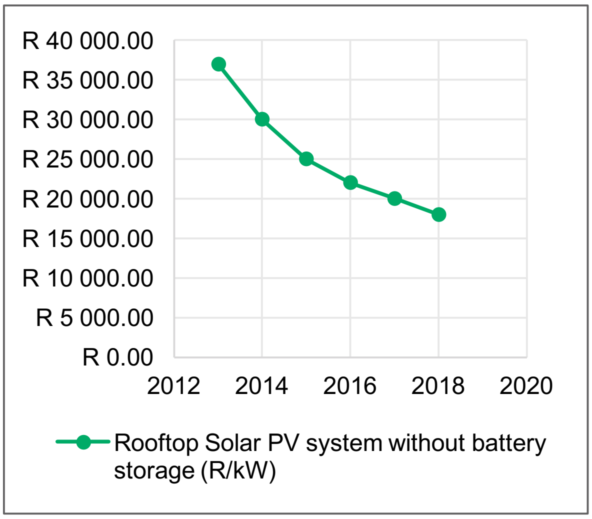

Figure 3:PV price curve for systems smaller than 10 kWp (R/W_p)

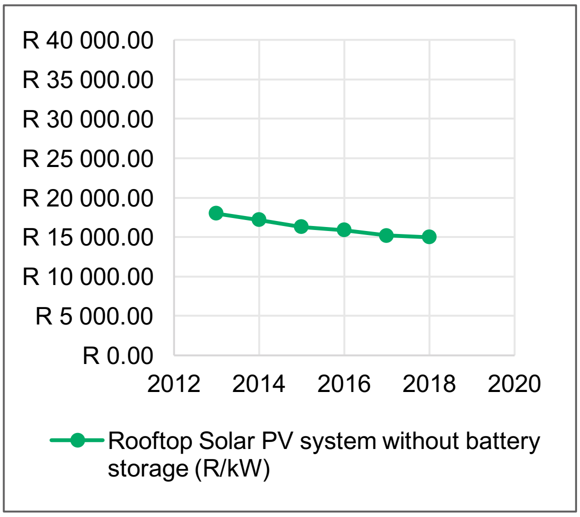

Figure 4: PV price curve for systems larger than 100 kWp (R/Wp)

Municipal electrical grid parity price

Municipal electrical grid parity is a term used to describe a point in time when an alternative energy source, in this case solar PV, can generate electricity at a Levelised Cost of Electricity (LCoE) that is less than or equal to the cost of the electricity available on a municipal electrical grid.

Given that Eskom (and therefore Municipality's) electricity prices will continue to rise (possibly by more than 12% each year for at least the next 5 years) and the price of alternatives is rapidly decreasing, South African may soon experience municipal electrical grid parity for various alternative energy sources. Table 2 displays the current 2015/16 Eskom tariffs along with an example of a municipal residential tariff.

Table 3: 2015/16 Eskom Tariffs & Example municipal residential tariff

	Summer	Winter
Peak	94.40c/kWh	289.43c/kWh
Standard	64.97c/kWh	87.68c/kWh
Off peak	41.22c/kWh	47.62c/kWh

Example municipal residential tariff	
Block 1 (0-600kWh)	175.90 c/kWh
Block 2 (600kWh<)	213.90 c/kWh

[8] Kilo-Watt peak (the rated peak output of solar PV panels)
[9] This does not include any backup supply options, such as batteries or generators.

The LCoE of PV systems can differ depending on the type of technology used, financing options, project life, interest rates and customer discount rate.

Table 3 displays the information used to estimate the LCoE for average small (10 kW_p) and large PV systems (100kW_p). Making use of the large system detailed below, a PV customer can generate an LCoE of approximately R1.30 per kWh.

The smaller system detailed below will generate an LCoE of approximately R1.68 per kWh. Despite the high LCoE, PV can often be competitive with residential tariffs in municipalities with good solar resources, low PV system costs and high electricity tariffs for residential customers (see for example the tariff displayed in Table 3).

Table 4: LCoE for a small (10kWp) and large (100kWp) PV system

Solar PV system	Large system	Small system
Solar Photovoltaic System Size	100 kWp	10 kWp
Total System Cost/Watt	17 000 R/kWp	22 000 R/kWp
Total System Cost	R1 700 000	R220 000
Project Life	25 years	25 years
Operations and Maintenance Cost		
Annual Operations and Maintenance Cost	R85 000 per year	R11 000 per year
Annual Operations and Maintenance Adjustor	3%	3%
Future Inverter Replacement Cost	300 R/kW	300 R/kW
Inverter Life (replace every X years)	5 years	5 years
Financing Assumptions		
% Financed w/ Cash	20%	20%
% Financed w/ Loan	80%	80%
Loan Interest Rate	18%	18%
Loan Period	20 years	20 years
Customer Discount Rate	6%	6%

PV system cost breakdown

The cost of installing a PV system is driven by the cost of the following elements:

- The solar panels/modules
- The inverter
- The balance of system cost (installation and commissioning and project development)

The equipment components of the PV system make up the majority of the overall cost, with the solar panels/modules and the inverter accounting for more than +-80% of total costs. Balance of system costs (BOS) that include installation, commissioning and project development accounts for the remaining +-20%.

The breakdown of the system costs, between solar modules, inverters and BOS, have remained proportionally constant with all components significantly decreasing in price.

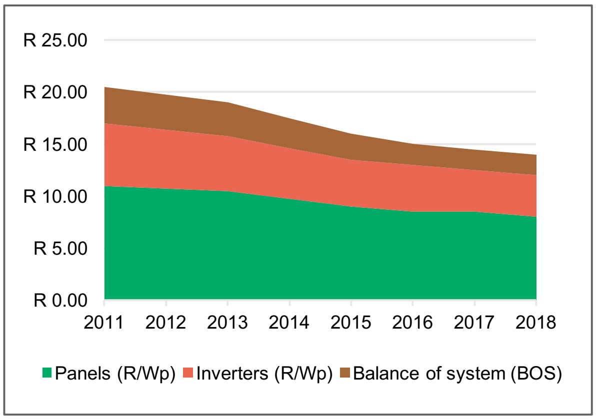

Figure 6: The breakdown of PV system costs as the system costs decrease over time for PV systems greater than $100kW_p$.

5. What tariff can a customer expect and why is it designed in this way?

Sustainable tariff design is a key issue for regulatory authorities in the changing energy landscape. Effective SSEG tariffs are quickly becoming the most prominent financial tool for promoting SSEG in South Africa. South Africa is currently experiencing an electricity supply crisis, with peaking plants having to be run outside of peak periods, pumped storage facilities being fully utilised, industrial load curtailment being requested and load-shedding being invoked more and more regularly. Within this landscape, tariffs should be aimed at protecting net surplus in a way that is fair and sustainable, supporting relevant government greening objectives and contributing towards resolving energy shortages.

1.1. Basic tariff elements

Modern electricity tariffs should all include network costs, service charges and a variable energy charge.

Network cost (R/connection size i.e. 10A, 20A) - It must be ensured that the fixed costs associated with maintaining and operating the network are recovered through appropriate network charges. This cost needs to be implemented across all consumers to ensure equity and transparency. It is very important that these network costs are not different for SSEG consumers. Implementing network charges for SSEG consumers only creates poor incentives for PV installations and as a result could exclude many consumers from considering PV as a potential option given the limited potential gain.

Service charge (per customer charge) - It must be ensured that the fixed costs associated with providing a retail service network (metering, billing, consumer call centre) are recovered through appropriate fixed charges.[10] As with the network cost, this cost needs to be implemented across all consumers to ensure equity and transparency.

Energy charge (c/kWh) – it must be ensured that the costs associated with purchasing energy from Eskom are recovered through an appropriate energy charge. This charge is a variable cost to the customer that is associated with the amount of energy a customer consumes.

1.2. Principles for adjusting tariffs to accommodate the SSEG environment

1.2.1. Introducing a feed-in rate

The only difference between a consumption electricity tariff and an SSEG tariff should be the addition of a feed-in component. There are many different approaches to setting feed-in rates and they can be broadly grouped into two main categories: value-based and cost-based.

Cost-based - establish the rate based on the cost of SSEG plus a targeted return.

Value based - determines the rate based on the value of that energy to the system as a whole. This would be the avoided energy cost/purchases, and, if any, the network and line losses costs. It can also include other positive externalities such as climate change mitigation, reduced health impacts, less air pollution and increased supply security.

[10] The daily service charge along with charges for consumption and credits for generated electricity fed onto the utility network will be billed monthly (as is done for other municipal services e.g. water and rates).

1.2.2. Ensuring that tariffs are transparent

It is important that any changes to the tariff structure or the introduction of a new SSEG tariff are done in combination with some degree of consumer engagement (as is mandatory as part of the National Energy regulator of South Africa (NERSA) tariff approval process). This engagement should be underpinned by a transparent tariff policy which is accessible to the public and easy to understand. More than just formulating a tariff policy and making it available to the public, it is recommended that the public consultations around electricity tariff changes be used as an opportunity to explain the tariffs and how consumers can adapt their energy usage to manage their electricity costs more effectively.

1.2.3. The importance of cost of supply study

Cost of study supplies should be carried out by all municipalities prior to developing new tariffs. A full cost of supply exercise should be carried out to determine the true, fixed and variable costs of supplying electricity to consumers. Ideally the costs should also be segmented by appropriate consumer type.

1.2.4. Developing accurate customer load profiles

Sample high-resolution consumer demand data should be collected over a period of time and used to generate representative high resolution load profiles[11]. These load profiles can be used to model the resulting net electricity revenue and margins resulting from the proposed tariff change. This will help verify revenue sufficiency and the effectiveness of the designed tariff. The impact on typical customer electricity bills from applying the various tariffs under different scenarios should also be modelled and analysed. This will help test the fairness of the tariffs to the different customer types.

1.2.5. Encouraging economically optimised PV installations

All tariff policies and tariffs should be designed in such a way as to promote installations that are economically efficient. The tariff needs to ensure that customers install a system that results in the lowest possible levelised cost of electricity (LCOE). This may mean that customers are incentivised to install larger and/or higher quality systems. A lower LCOE will result in a better return on investment. A system offering a better return on investment will require less of an incentive type tariff and will hence have a smaller impact on the municipality.

1.2.6. Setting a feed-in payment duration

Payment duration refers to the agreed period that a SSEG customer will receive a specified feed-in rate. Electricity customers and SSEG developers that are looking to implement a SSEG project require a reduced risk profile. Risk involved in SSEG project development can be reduced by ensuring that the payment stream will not end before the SSEG customer or developer has had a chance to recover their investment.

Long term price security in the midst of rapidly increasing electricity prices is important for lowering the risk of PV investment. This reduced risk profile will ensure lower system costs for developers and customers. With lower costs for SSEG the municipality is able to generate the same uptake with lower tariff incentives.

Providing customers with certainty can reduce the impact on municipalities while still ensuring that the municipality uses its tariff policies to support the uptake of SSEG. Payment durations should be secure for as close to the lifetime of the projects as possible wherever feasible

[11] Ideally this should be measured as kWh per 30 minute interval, per customer and over a period of several years. Generally this type of data will not be available until an Advanced Metering Infrastructure (AMI) is in place.

1.2.7. Any customer should be able to be on an SSEG tariff

SSEG tariffs should be design so that customers cannot reduce their bill by simply switching onto that tariff (without making any other changes to self-consumption or generation).

1.2.8. TOU metering for SSEG

All customers with SSEG installations should be on a time-of-use tariff (if a time-of-use tariff is available for that customer class). A time-of-use tariff is more cost-reflective than a flat or two-part tariff in that it accounts for the varying costs of generating and supplying electricity. Electricity demand and prices vary throughout the day and year and solar panels generate a vast majority of their power the cheaper sunshine hours.

1.2.9. Ensure that grid connection remains the most appealing option

It is important that all decisions regarding SSEG tariffs are taken to ensure than remaining grid-tied is the most attractive option both financially and in terms of security of supply when compared to off-grid alternatives. Grid defection would be the worst case scenario for the municipality and the grid as a whole.

6. What is the PV application process and who is eligible to apply?

This section is meant to give some information on 1) the application process for becoming a registered SSEG installer (grid-tied and off grid) and 2) on who is eligible to apply.

It is essential that all customers wishing to install a grid-tied SSEG system (regardless of generation capacity) complete the relevant sections of the application process in full, and that written approval is received from the Municipality before system installation commences. The Municipality needs to ensure that, among other considerations, the SSEG installation can be accommodated on the municipal electrical grid and that the total SSEG capacity of the municipal electrical grid has not been exceeded.

Grid-tied system

The *Generation and Embedded Generation* application form must be completed by customers for all types of embedded electricity generation, including renewable energy and cogeneration[12] that is – or is planned to be – connected to the municipal electrical grid. This form covers applications for the installation of a SSEG system smaller than 1 MW. Should tariff or metering changes be required for the SSEG installation, the *general application* form for new or *modified connections*[13] form must also be completed. The forms need to be made available on the Municipality's website.

The following steps need to be made clear to electricity customers wishing to install rooftop PV:

Customer application process[14]:

- Step 1: Visit the Municipality website to find more information and all the necessary forms.
- Step 2: Complete the Generation and Embedded Generation application form and, if required, the general application form for new or modified connections.
- Step 3: Obtain permission from other relevant Municipality departments (Planning and building management approvals, health and air quality approvals and environmental approvals)
- Step 4: Submit completed application form/s and the required attachments.
- Step 5: Installation commencement upon approval from the Municipality and signing of the Supplemental contract for embedded generation (Supplemental to the contract for the supply of electricity).
- Step 6: Commissioning and documentation to be submitted to Electricity Services Department (a division within the Municipality).
- Step 7: Municipal inspection of installation and wiring if necessary.
- Step 8: Approval granted to connect to the municipal electrical grid and generation commences.
- Step 9: Repeat the process in the case of SSEG capacity expansion.

Off-grid

Standalone generators (not connected to the municipal electrical grid in anyway) do not need permission from the Municipality. However, approvals from other departments are still necessary (health, building). If the SSEG system will never be grid-tied to any electrical installation connected to the municipal electrical grid, a registered person in terms of *the Electrical Installation Regulations (2009)* must install the SSEG system and issue a Certificate of Compliance issued to the owner in terms of *South African National Standard - The wiring of premises* (*SANS 10142-1 – Low-voltage installations*), which confirms that the SSEG system is not grid-tied to the municipal electrical grid and

[12] The generation of electricity using waste heat.
[13] This form is normal application for new connections as used by the Municipality
[14] Please see the *Guidelines for Small Scale Embedded Generation* for the full application process.

that it only supplies an off-grid electrical installation. The Municipality can request a copy of the Certificate of Compliance at any time.

7. What information is required in the application form and why is it required?

This section is meant to provide more information on the *Generation and Embedded Generation* application form that is required to become a legal SSEG installation[15]. This application form is used for the connection of any embedded generation under 1MVA, located on residential, commercial or industrial sites where electricity is also consumed. A separate form titled *Application for a new or modified electricity supply service* must also be completed, except for installations where reverse power blocking is to be installed. If the embedded generator is to be configured as a standby supply after islanding from the utility supply, the generator will have to be connected to the existing internal wiring of the property. In such a case, the property owner must obtain a certificate of compliance from a qualified electrician.

The parallel connection of any generator to the municipal electrical grid has numerous implications for the local Municipality. It must therefore be regulated and managed. The goals of the application form are to:

- Ensure the safety of the utility staff, the public and the user of the generator.
- Mitigate the impact of the physical presence of the generation on neighbours (e.g. visual, noise)
- Mitigate the impact on the quality of the local electrical supply, and metering and billing issues.

The application form can be segmented into the following broad sections displayed in Table 5:

Table 5: Broad outline of small scale embedded generation application form

Property name and location, name, account & contact details of property owner
SSEG Installation information
▪ Application type – Residential, Commercial/Industrial, new or revised ▪ Planned construction schedule – Projected construction start date and projected in-service date of SSEG ▪ Mode of embedded generation – Gird-tied without reverse flow protection, gird-tied with reverse flow protection (no feed-in), system used solely for exporting to the municipal electrical grid or SSEG to be used solely for wheeling. ▪ Total capacity of embedded generation (system size) ▪ Proposed consumption and generation levels (monthly) ▪ Type of prime mover and fuel source for embedded generation – Photovoltaic, concentrated solar power, small hydro, landfill gas, biomass, biogas etc. ▪ Battery storage ▪ Type of energy conversion – Synchronous generator, induction generator, inverter, fuel-cell, dyno set. ▪ Make & model of key generating equipment ▪ Electrical parameters of generator and unit transformers ▪ Protection details – Method of synchronising, anti-islanding, generator control and other main protection to be applied
SSEG site information
▪ Site plan, land use zoning ▪ Preliminary design ▪ List of regulatory approvals, requirements and normative references
Installer Details

[15] This section is only relevant to the *Generation and Embedded Generation* application form is the form used as part of this SSEG resource pack

It is important to note that the following documentation must also be completed by the applicant and must be attached to the application form:

- Final copy of the installation's circuit diagram.
- Inverter Type Test - The inverter type test certification requirements are specified in the NRS 097-2-1. Type testing is to be undertaken by a 3rd party test house such as Bureau Veritas, KEMA or TÜV Rheinland. Inverter suppliers should be asked to provide the necessary certification before the equipment is purchased. It is strongly recommended that the Municipality be consulted before equipment is purchased to ensure its acceptability by the Municipality. A full list of recommended inverters is provided as part of the resource pack.
- Factory setting sheet or other documentation showing that the inverter has been set according to NRS 097-2-1
- An electrical installation *Certificate of Compliance as per SANS 10142-1*
- A signed *Supplemental Contract for Embedded Generation*. This is a legally required contract that governs the relationship between the Municipality and the customer. The contract is valid for as long as the project is in existence.
- A signed *Application for a new or modified electricity supply service* if required.
- Operation and Maintenance Procedure – installation responsibilities after commissioning.

Forms that may also be required

- *SSEG Installation Commissioning Report* (provided as part of the resource pack)
- *SSEG Installation Decommissioning Report* (provided as part of the resource pack)

9. What are the relevant standards and regulations in terms of SSEG in South Africa?

This section is meant to provide more information on the relevant provincial and national regulations and standards that govern the energy and specifically the SSEG legal environment. There are a number of standards and regulations of which all relevant stakeholders must be aware:

- Electricity Regulation Act, Act 4 of 2006 and Electricity Regulation Amendment Act, 28 of 2007 as amended
- South African Distribution Code (all parts)
- South African Grid Code (all parts)
- South African Renewable Power Plants Grid Code
- Occupational Health and Safety Act 1993 as amended
- SANS 10142- Parts 1 to 4: The Wiring of Premises
- SANS 474/ NRS 057 Code of Practice for Electricity Metering
- NRS 048: Electricity Supply– Quality of Supply
- NRS 097-1: Code of Practice for the interconnection of embedded generation to electricity distribution networks: Part 1 MV[16] and HV[17] (Eskom 240-61268576 / DST 34-1765: Standard for the interconnection of embedded generation, is applicable until published)
- NRS 097-2: Grid interconnection of embedded generation: Part 2 Small scale embedded generation

Electricity Regulation Act, Act 4 of 2006 and Electricity Regulation Amendment Act, 28 of 2007 as amended - The act states that no person may, without a license issued by the regulator (NERSA), operate any generation facility. The *Electricity Regulation Act, Act 4 of 2006* holds that exemption is held for non-grid-tied projects. Note that NERSA has issued a communication giving license exemption to SSEG installations in municipal areas under 100kW.

South African Distribution Code (all parts) - The South African Distribution Code applies to all entities connected to the distribution network, including embedded generators. It sets the basic rules for connecting to the distribution network, ensures non-discrimination to all users connected to the distribution network and specifies the technical requirements to ensure the safety and reliability of the distribution network.

South African Grid Code (all parts) - The South African Grid Code contains the connection conditions that are required by all generators, distributors and end-users (customers) connected to the municipal electrical grid, as well as the standards used to plan and develop the transmission system.

South African Renewable Power Plants Grid Code - This document sets out the technical and design grid connection requirements for renewable power plants (0-1MVA LV[18]) to connect to the transmission or distribution network in South Africa.

Occupational Health and Safety Act 1993 as amended - The Occupational Health and Safety Act provides for the health and safety of the people by ensuring that all undertakings are conducted in such a manner so that those who are, or who may be, directly affected by such an activity are not negatively harmed as far as possible and are not exposed to dangers to their health and safety.

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[16] Voltage levels greater than 1 kV up to and including 33 kV.
[17] Voltage levels greater than 33 kV.
[18] Voltage levels up to and including 1 kV. (1kV= 1000 Volts).

Municipal Electricity Supply By-Law - This document provides the general conditions of supply of electricity, outlines the responsibility of the customers, systems of supply, measurement of electricity and the electrical contractors responsibilities.

SANS 10142- Parts 1 to 4: The Wiring of Premises - This document serves as the South African national standard for the wiring of premises in low and medium voltage networks (AC/DC). The aim of the document is to ensure that people, animals and property are protected from dangers that arise during normal as well as fault conditions, due to the operation of an electrical installation. Compliance to the standards and regulations as laid out SANS 10142-1 is required and proof should be provided via an electrical installation certificate of compliance. The implication is that a registered professional is required to sign the installation.

SANS 474/ NRS 057 Code of Practice for Electricity Metering - SANS 474 specifies the metering procedures, standards and other such requirements that must be adhered to by electricity licensees and their agents.

NRS 048: Electricity Supply– Quality of Supply - The NRS 048 series covers the quality of supply parameters, specifications and practices that must be undertaken to ensure correct and safe operation. The NRS 048-2 and NRS 048-4 have the most relevance to the operation and connection of SSEG's to the municipal electrical grid: NRS 048-2: 'Voltage characteristics, compatibility levels, limits and assessment methods' sets the standards and compatibility levels for the quality of supply for utility connections as well as for stand-alone systems. It is intended that generation licensees ensure compliance with the compatibility levels set in this document under normal operating conditions. NRS 048-4: 'Application guidelines for utilities' sets the technical standards and guidelines for the connection of new customers. It also sets the technical procedures for the evaluation of existing customers with regards to harmonics, voltage unbalance and voltage flicker.

NRS 097-1: Code of Practice for the interconnection of embedded generation to electricity distribution networks - Part 1 MV and HV (Eskom 240-61268576 / DST 34-1765: Standard for the interconnection of embedded generation, is applicable until published)

NRS 097-2: Grid interconnection of embedded generation: Part 2 Small scale embedded generation - NRS 097-2-1 (Part 2: Small Scale Embedded Generation, Section 1) this document serves as the standard for the interconnection of SSEG's to the municipal electrical grid and applies to embedded generators smaller than 1000kVA connected to LV networks of type single, dual or three-phase.

NRS 097-2-3 (Part 2: Small Scale Embedded Generation, Section 3) - this document provides simplified utility connection criteria for low-voltage connected generators.

10. Which by-laws should the Municipality have in place?

The purpose of this section is to highlight which municipal by-laws may be required when a Municipality endeavours to allow embedded generation onto the municipal electrical grid. In addition, this section also provides relevant examples of possible by-laws[19].

The provision of electricity services

It is important that the Municipality has relevant by-laws that regulate the supply of bulk electricity within the municipal boundaries.

Example:

1. *Only the Municipality may supply or contract for the supply of bulk electricity within its jurisdictional area.*
2. *The Municipality may permit the bulk supply or retail wheeling of electricity through its electrical grid by another electricity supplier which is licensed to supply electricity in terms of the appropriate Act.*
3. *The Municipality may permit the embedded generation of electricity to its customers subject to:*

3.1 A Supplemental Contract for Embedded Generation being entered into.

3.2 Compliance with the relevant requirements of the Municipality pertaining to the generation of electricity and the safety thereof.

3.3 Registration at the Municipality of all fixed installations where electricity is generated and compliance with the Municipality's safety and quality requirements.

4. *The surplus generation of electricity may be prohibited and the Municipality may determine conditions for such surplus generation pertaining to timing and quantity.*

Supply by agreement

It is important that the Municipality has relevant by-laws that limit the connection of embedded generation to the municipal electrical grid and enforce the registration of any and all embedded generation systems within their municipal boundaries

Example:

1. *No person may generate electricity by way of a fixed installation and feed into a municipal electrical grid unless an agreement has been concluded with the Municipality, and such agreement together with the provisions of this by-law, as well as any other legislation governing the licensing of generators, shall govern such generation of electricity.*
2. *No alternate electricity supply equipment provided by a customer in terms of any regulations or for his own operational requirements or generation may be connected to any installation without the permission of the Municipality.*
3. *Application for such approval must be made in writing and must include a full specification of the equipment and a wiring diagram.*
4. *The equipment must be so designed and installed that it is impossible for the Municipality's supply mains to be energised by means of a back feed from such equipment when the Municipality's supply has been de-energised.*
5. *The customer shall be responsible for providing and installing all such protective equipment.*
6. *Where, by special agreement with the Municipality, the customer's alternate supply equipment is permitted to be electrically coupled to, and run in parallel with the Municipality's supply mains, the customer shall be responsible for providing, installing and maintaining all the necessary synchronising and protective equipment.*

[19] Anyone using these by-laws for Small Scale Embedded Generation (SSEG), in part or in full, as a basis for their own by-laws does so on the basis that they indemnify and hold harmless the authors and their successors or assigns in respect of any claim, action, liability, loss, damage or lawsuit arising from their use of these by-laws.

Application for supply or generation

It is important that the Municipality has relevant by-laws that detail the enforced embedded generation registration/application process.

Example:
1. Application for the supply or generation of electricity must be made in writing by the prospective customer on the prescribed form obtainable at the office of the Municipality, and the estimated load, in kVA, of the installation, must be stated therein. Such application must be made as early as possible but not less than the time allowed by NRS047-1, paragraph 4.2.3 before the supply of electricity is required in order to facilitate the work of the Municipality.
2. Applicants for the supply or generation of electricity must submit the following documents above and beyond the documents required for their application:
2.1 An identity document or passport, and, in the case of a business, aletterof resolution delegating the authority to the applicant
2.2 A valid lease agreement, in the case of a tenant, or, in the case of an owner, a title deed or other proof of ownership of the premises for which a supply or generation of electricity is required.
2.3 An application for a new temporary supply of electricity shall be considered at the discretion of the Municipality which may specify any special conditions to be satisfied in such case.

Principles for the resale of electricity

Given that the Municipality now allows embedded generation on their electrical grid, it is important that the Municipality has relevant by-laws that regulate the wheeling[20] of the electricity now being generated within the municipal electrical grid.

Example:
1. Unless authorised by the Municipality, no person may sell or supply electricity supplied to his or her premises or generated by him or her under an agreement with the Municipality, to any other person or persons for use on any other premises, or permit or allow such resale or supply to take place.
2. The tariff at which and the conditions of sale under which electricity is thus resold shall not be less favourable to the purchaser than those that would have been payable and applicable had the purchaser been supplied directly with electricity by the Municipality.

Standby supply

Given that the Municipality now allows embedded generation on their electrical grid it is important that the Municipality has relevant by-laws that regulate islanding[21] and anti-islanding[22] of the electricity generators now connected within the municipal electrical grid.

Example:
1. Standby supply of electricity for any premises having a separate source of electricity supply may only be supplied with the written consent of the Municipality.
2. Upon interruption of the electricity supply the Municipality may supply standby electricity in any manner as necessary.

[20] The transportation of **electric power** over transmission lines from where it is generated to where it is consumed.

[21] An instance when the generator supplies power to a portion of the customer's electrical grid during a general power outage

[22] The ability of an SSEG installation to instantly and automatically disconnect the generator from the local municipal electrical grid whenever there is a power outage in the municipal electrical grid, thus preventing the export of electricity to the municipal electrical grid from the SSEG. This is done primarily to protect municipal workers who may be working on the municipal electrical grid and who may be unaware that the grid is still being energized by the SSEG.

Metering

Given that the Municipality now allows embedded generation on their electrical grid it is important that the Municipality has relevant by-laws that regulate the metering of the embedded generators connected to the municipal electrical grid.

> ***Example:***
> 1. *The Municipality shall, at the customer's cost in the form of a direct charge or prescribed tariff, provide, install and maintain appropriately rated metering equipment at the point of metering for measuring the electricity supplied and generated.*

Norms, standards and guidelines

It is important that the Municipality has relevant by-laws that allow the Municipality to determine and publish norms, standards and guidelines relevant to embedded generation within the municipal boundaries.

> ***Example:***
> 1. *The Municipality may determine and publish norms, standards and guidelines which prescribe appropriate measures to save energy or to reduce the use of electricity and such norms standards and guidelines must be kept in the form of an operational manual.*
> 2. *The norms, standards and guidelines contemplated in subsection (1) may differentiate between communities, geographical areas and different kinds of premises.*

Right to disconnect supply

The Municipality must have a by-law in place that allows them to disconnect a customer's electricity supply if the customer is found to have illegally connected SSEG to the municipal electrical grid (either before or after their electricity meter).

Example:

1) *The Service Provider may, subject to subsection (2), disconnect the supply of electricity to any premises, which could include the restricting and/or allocation of credit purchases for prepayment meters as set out in the Service Authority's Credit Control and Debt Collection Policy— 560 Provinsie Wes-Kaap: Provinsiale Koerant 6727 16 April 2010*
   a) *where the person liable to pay for such supply fails to pay any charge due to the Service Provider in connection with any supply of electricity which he or she may at any time have received from the Service Provider in respect of such premises; or*
   b) *where the Service Authority has requested the Service Provider to disconnect the supply of electricity where there are outstanding municipal service fees, surcharges on fees, property rates and other municipal taxes, levies and duties; or*
   c) *where tampering with the service connection or supply mains has occurred.*
2) *The Service Provider must give a person referred to in subsection (1)(a) and any person residing in the premises notice of—*
   a) *the intention to disconnect electricity supply to the premises of such person;*
   b) *a reasonable opportunity for such person to make representations in respect of the intended disconnection; and*
   c) *all the relevant information including reasons for the intended disconnection and the notice period on or after which the disconnection will be effected.*
3) *The Service Provider may disconnect the supply of electricity to any premises without notice under the following circumstances;*
   a) *where there is a case of grave risk to any person or property; or*
   b) *for reasons of community safety or the safety of emergency personnel.*
4) *For circumstances other than listed in sub-section (1) and (2), where any of the provisions of this By-law or the Regulations are being contravened, the Service Provider shall give the person concerned fourteen days' notice to remedy his or her default prior to disconnection.*
5) *After the disconnection contemplated in subsection (1), the fee as prescribed by the Service Provider for such disconnection or the reconnection of the service shall be paid by the person concerned.*
6) *In the case where an installation has been illegally reconnected on a customer's premises after having been previously legally disconnected by the Service Provider, or in the case where the Service Provider's electrical equipment has been tampered with to prevent the full registration of consumption by the meter, the electricity supply may be physically removed from those premises.*

This is by no means an exhaustive list but provides the basics that should allow the Municipality to allow embedded generation into their electrical grid while protecting all stakeholders.