

# Small-scale embedded generation: Solar PV

## Challenges and approaches for municipalities

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### Sustainable Energy Africa

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July 2014

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## Aim

This document provides background and outlines key steps to consider in the integration of solar PV small-scale embedded generation (SSEG) in municipal electricity distributor procedures and distribution grids.

## Steps to enable SSEG installations

To develop procedures and systems to accommodate solar PV SSEGs into municipal distribution operations, the following need to be considered:

1. Awareness of the regulatory environment
2. Awareness of technical standards governing SSEGs (NRS 097 series amongst others)
3. Clarify any technical concerns or conditions that the municipality wishes to place on SSEG customers in addition to the existing NRS097 and other NRS standards
4. Tariff setting for SSEGs to protect municipal revenue ( the need for this will depend on the likelihood of the central buyer NETFIT<sup>1</sup> SSEG reimbursement scheme taking effect)
5. Billing system modification to accommodate net generation (if net generation is to be allowed)
6. Develop necessary documentation:
  - guidelines for potential SSEG applicants
  - application form
  - contract for SSEG customers (Supply Agreement)
7. Municipal staff capacity:
  - Training of municipal staff to deal with applications and installation inspections (if applicable)
  - Providing clear explanation to political leadership

More information is given in the relevant sections of this document.

## Background

Due to steep increases in the price of grid supplied electricity, from both Eskom and municipalities, and a steady decline in the price of solar PV technology, PV small-scale embedded generation (SSEG) - i.e. 'rooftop' type systems - are becoming financially more attractive in South Africa. Increasingly such systems are being installed on businesses and residences, sometimes with and sometimes without official approval to connect to the grid.

### The problem faced by municipalities

Municipalities are realizing that there is a need to be proactive in developing appropriate procedures and standards for SSEG integration to avoid unregulated proliferation of installations.

Some municipalities already have procedures in place to guide prospective SSEG installers regarding system criteria and standards to be followed, and have developed associated tariffs. Eskom also has formalized procedures and tariffs for SSEGs. Many municipal distributors are concerned about the current situation:

- on the one hand they are **obliged to ensure that the distribution grid power quality and safety standards are upheld** – and are under threat of extreme penalties if they do not. This puts pressure on them to enforce demanding standards on SSEG installations, which in turn has a cost implication for SSEG installers.

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<sup>1</sup> NETFIT – a proposed national feed-in tariff for SSEGs (explained later in document)

- on the other hand they realise that **unless they have a user-friendly framework around installation application and approval, SSEG systems will simply be installed and grid connected** by one of the solar PV supply companies on behalf of customers without official approval.
- A further issue for municipalities revolves around **potential revenue loss from reduced sales** due to PV uptake amongst customers. This can be a serious issue because not only are the wealthier, hi-consuming customers likely to move to PV first (and these customers are important sources of revenue), but it may threaten the revenue needed to cross-subsidise poor households. Current residential tariffs in particular are not designed to accommodate SSEGs, and residential SSEGs can thus result in some revenue loss. For this reason specific SSEG tariffs have been introduced to protect municipal revenue. **These tariffs, although sound practice for municipalities, result in an unresolved tension:**
  - they make it less attractive for customers to install solar PV systems and thus slow the ‘clean energy’ advancement of municipalities, as well as increasing the tendency for customers to install systems without official approval.

It is worth noting that municipalities are responding to these issues in different ways, with different tariffs, and some, such as Nelson Mandela Bay Metropolitan Municipality, have even decided to not put in place a revenue protecting tariff, but simply allow meters to run backwards, as they believe that the related economic stimulus is worth the immediate revenue loss.

### Lack of regulatory clarity

In addition to the above local government issues, there has been regulatory ambiguity at the national level regarding SSEGs linked to NERSAs 2011 **“Standard Conditions for Small Scale (less than 100kW) Embedded Generation within Municipal Boundaries”** document. A national working group which includes SALGA, AMEU, Eskom and technical experts is engaging with NERSA on this issue.

The overarching national electricity planning framework – the Integrated Resource Plan (still a draft) – is now also starting to consider the role of SSEGs in the national electricity supply picture.

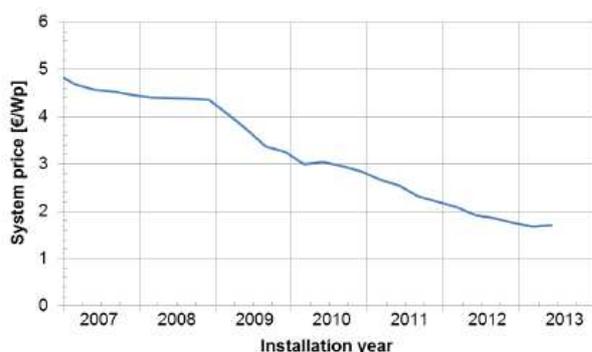


Figure 1: International solar PV price trends - to which South Africa is subject (Source: Fraunhofer Institute, Freiburg, 2014.)

### Cost trends in solar PV

South African PV price trends mirror internationally decreasing price trends, with a slight delay. Although there is some local manufacture of PV panels and inverters, most are imported and are thus affected by the exchange rate. Overall, the price trend in South Africa has been decreasing, and this is expected to continue – although fluctuations may occur.

### Payback periods

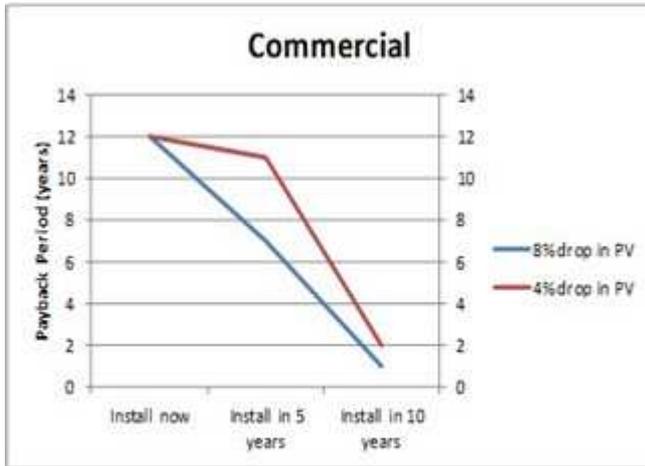


Figure 1: Typical payback period for financed PV SSEG systems in the commercial sector

Currently, payback periods for solar PV investments are estimated to be between 8 and 15 years (depending on financing rates and electricity tariffs)<sup>2</sup>. Given that solar PV panels generally come with 20 year guarantees, investing in such systems is increasingly attractive, even with lengthy payback periods. In 10 years' time, payback periods are expected to be significantly reduced, and at this time it is expected to be an obvious choice to install such systems. In fact a solar PV leasing scheme is already being developed by a local service provider<sup>3</sup>, where customers will pay no extra for their combined power bills and PV system lease instalments compared with their current bills.

### Installation examples on Municipal and other government buildings

Several municipalities are installing solar PV SSEGs on their facilities, and others have plans to do so in the near future. Ekurhuleni is issuing a tender for two 150kWp systems on municipal buildings, and eThekweni is intending to install around 500kWp in the next two years. Cape Town has installed a 10kWp and 20kWp system on their buildings, and is awarding a tender for another 80kWp system. Some other municipalities also have similar initiatives. In addition, the Gauteng government announced a programme to install 300MW of solar PV on their building roofs starting in the 2013/14 financial year, at a cost of around ZAR11 billion<sup>4</sup> (this seems ambitious and would require approvals from NERSA and local electricity distributors before proceeding).

### Potential PV uptake in municipalities

In the residential sector significant solar PV uptake is only considered likely amongst the high-end consumers – those with consumption of 1000kWh/month or more. Based on analyses undertaken for several South African cities, the potential uptake of solar PV in the next decade is estimated in the below table.

Table 2: Solar PV uptake estimates within 10 years<sup>5</sup>

Intervention	Low Penetration (%)	High Penetration (%)
Residential PV	2.5%	15%
Small commercial PV	15%	50%
Industrial PV	15%	50%

<sup>2</sup> Source: Solar PV Cost-Benefit Analysis Spreadsheet Tool developed by Sustainable Energy Africa, 2014. Available on <http://www.cityenergy.org.za/category.php?id=3>

<sup>3</sup> Source: Lease finance initiative for rooftop PV. ESI Africa, March 13, 2014

<sup>4</sup> Source: *The Leading Edge*, July 2013. Institute for Futures Research, University of Stellenbosch, Cape Town.

<sup>5</sup> Based on: *Impact of localised Energy Efficiency (EE) and Renewable Energy (RE) on Ekurhuleni's finances over the next 10 years*. February, 2014. Sustainable Energy Africa.

## Revenue impact of customers installing PV SSEGs

Municipal utilities stand to lose revenue with the widespread uptake of solar PV, linked with potential further revenue losses from solar water heater (SWH) and other energy efficiency (EE) intervention uptake.

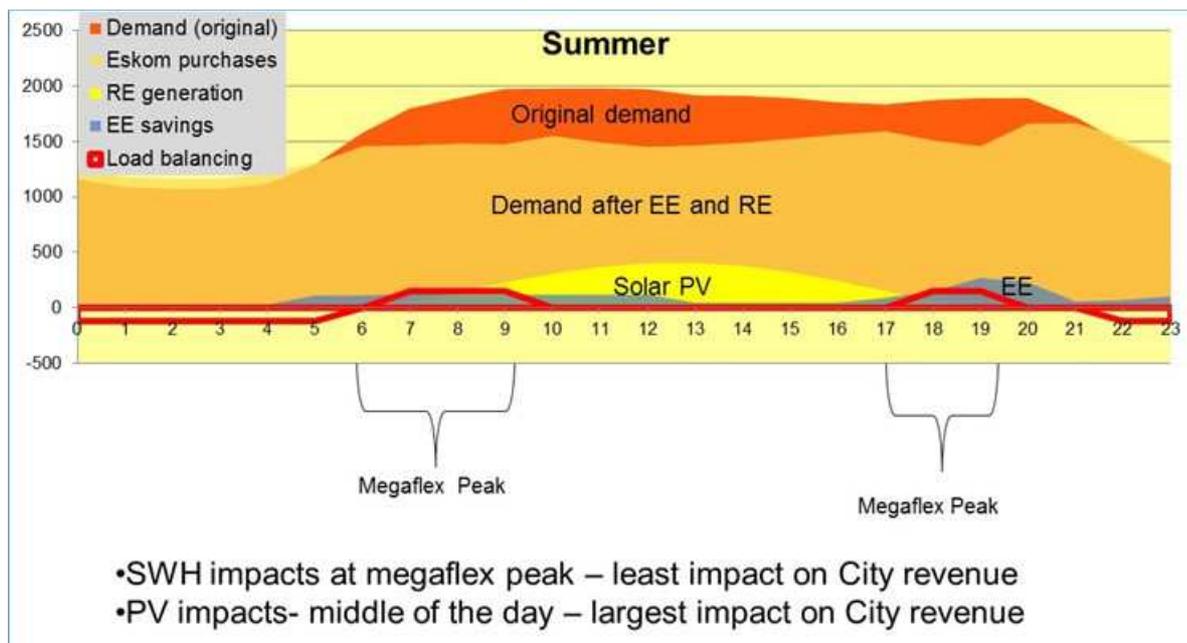


Figure 2: Illustrative impact of PV SSEG and other interventions on municipal load profile (which affects the revenue loss calculations given that bulk electricity purchases from Eskom are charged at different rates over peak and non-peak periods – as per the Megaflex tariff)

The revenue loss estimates for Polokwane from solar PV implementation are shown below, and are typical of losses for South African cities<sup>6</sup>. The residential sector is assessed with and without a ‘fixed charge’ – type tariff (i.e. including a fixed charge for residential customers with solar PV installations to ensure fixed costs are recovered irrespective of net energy consumption of these customers).

Table 1: Revenue impact of solar PV rollout as a % of total electricity revenue (example of Polokwane)

year	Residential PV fixed charge	Residential PV no fixed charge	Commercial PV	Industrial PV
0	0.00%	0.00%	0.00%	0.00%
3	0.00%	-0.02%	-0.04%	-0.04%
5	-0.01%	-0.05%	-0.14%	-0.13%
10	-0.04%	-0.14%	-0.37%	-0.33%

The revenue impact of PV is expected to be relatively minimal, although this may vary depending on the particular municipal tariffs applicable. Analyses indicate that the revenue losses from solar water heater

<sup>6</sup> Estimates are derived from a specific tool developed by Sustainable Energy Africa for purposes of municipal electricity revenue impact estimation from a range of interventions.

installations and other energy efficiency interventions are likely to be much higher and of greater concern that that resulting from estimated solar PV rollout, simply because of the much greater penetration anticipated for these interventions. This is illustrated in Figure 4 for Polokwane, which is similar to impacts in other South African cities<sup>7</sup>.

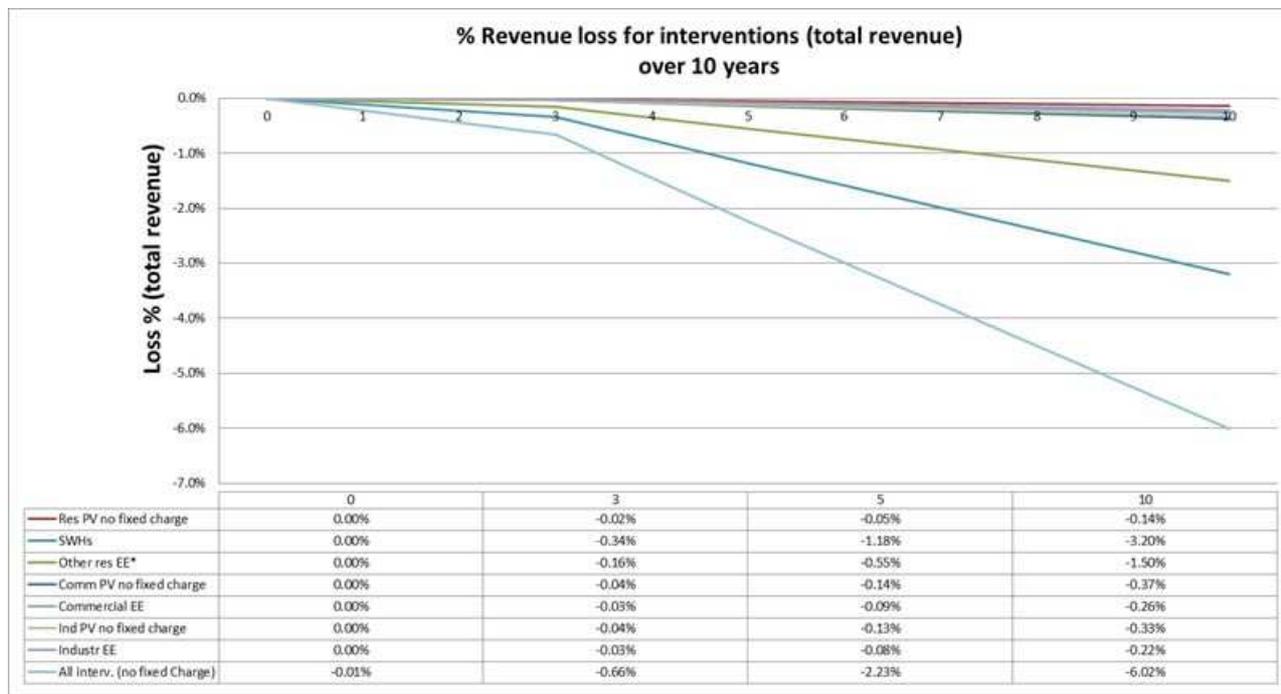


Figure 3: Revenue impact of SWH and EE rollout compared with solar PV revenue impact (as a % of total electricity revenue) – example of Polokwane

## Tariff setting to protect revenue

Although revenue losses from anticipated solar PV rollout are not significant, it is sound practice for municipalities to ensure that such rollout does not impact negatively on the municipality. There are various options to mitigate revenue losses. Typically the municipality increases electricity tariffs to meet budget, however, this adversely affects the poor and the economy. High electricity prices also make the financial case for PV SSEGs more attractive, which accelerates their uptake and further revenue loss. Therefore other measures need to be explored.

### Decoupling of tariffs

Presently residential tariffs generally only have an energy charge and no fixed charge. A reduction in kWh use due to a customer having a PV SSEG installation therefore leads to inadequate recovery of the non-energy expenses of providing electricity incurred by the distributor. To avoid this unsustainable (and inequitable) situation, the most sensible option is to protect revenue using a decoupled tariff which is composed of a fixed charge and energy charge. This is the most transparent tariff as it reflects the cost of the service - i.e. having access to the grid, as well as the actual price of electricity. For example a residential customer would pay 55c/kWh, which would be passed on directly to Eskom by the municipality, and the municipality would charge a monthly fee of R400 to cover the cost of supplying that customer with electricity. In this way the municipality protects its revenue, no matter how much electricity is or isn't sold. It

<sup>7</sup> Such revenue analyses have also been undertaken for eThekweni, Ekurhuleni and Cape Town, all of which support this conclusion.

can also encourage the electricity department to support energy saving, as this will reduce the demand placed on their network. The reduction of the energy charge however will have the effect of making the business case for SSEGs less attractive because the saving per kWh generated by the SSEG is reduced, and so would slow down the uptake for a period. However, this model will allow a fair and equitable tariff structure to develop, protect municipal finances, and promote a more stable SSEG business models into the future.

It may be prudent to apply the decoupled tariff across the board, as a compulsory decoupled tariff only for those customers who have PV encourages illegal connections as they would prefer to benefit from the higher energy charge on their old tariff. In other words, their savings from PV generation would be greater due to the higher energy charge on the old tariff. For example a PV generator which generates 5kWhs in a day will save R7.50 from an energy tariff of R1.50/kWh, and only R2.50 from an energy tariff of 50c/kWh.

### NETFIT

The NETFIT business case proposed by Eskom describes a mechanism to compensate municipalities for monetary losses as a result of PV. This is gathering support and could be implemented nationally. NETFIT, if implemented correctly, would solve the revenue loss problem from PV generation without any tariff modification by the municipality. However whether and when it may be implemented remains uncertain, and thus it should not be counted on.

### Metering and reverse feed

Municipalities currently differ on whether they allow reverse feed from solar PV SSEG systems, or whether they merely allow SSEG generation to offset 'own use'. Nelson Mandela Bay Municipality intends to allow full reverse feed. The City of Cape Town does not allow reverse feed on average (averaged over a financial year), although they intend to in future. City Power, in Johannesburg, and eThekweni Municipality will also allow reverse feed in future.

Central to the issue of reverse feed is the metering technology. Standard prepayment and spinning disc meters are not appropriate for this purpose (in fact most prepayment meters increment no matter which way power flows,, and spinning disc meters often can reverse but are not designed to do so accurately). Specific bi-directional meters are required as specified in the NRS097-2-1 of 2013 (draft). Suitable AMI bi-directional credit meters are available, and bi-directional prepayment meter solutions are expected to become available in future.

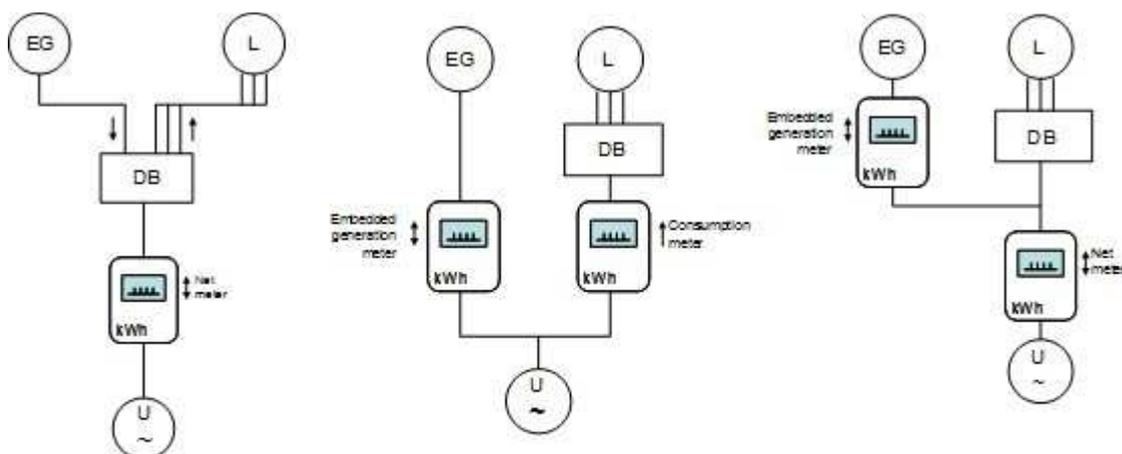


Figure 1: Metering configurations covered by the NRS097-2-1 (Net metering, Separate metering, Separate embedded metering respectively)

## Billing systems

Together with suitable metering technology, the billing system of the municipality needs to be able to accommodate net generation if the municipality wishes to allow this option.

## Regulatory compliance

### NERSA Standard conditions for municipal SSEGs

The 2011 NERSA Standard Conditions for SSEGs within municipal boundaries are referred to as ‘guidelines’ within the document, and thus are of uncertain regulatory status. They only deal with systems under 100kW, and indicate that such systems do not require generation licenses from NERSA. The conditions require the municipalities to:

- Maintain a database of all small scale (<100kW) embedded generation within their area and report to the Regulator on an annual basis proving the following information:
  - number of installations for each technology
  - total capacity for each technology installed
  - the total energy each technology has generated onto their system in each “Time of Use tariff” metered time period
  - complaints that they have received from customers on the same circuit as the generation about quality of supply
  - all safety related incidents involving this generation
  - the tariffs applicable to these installations
  - the Standard Supply Agreement.
- Ensure safety of municipal operating personnel.
- Ensure that the NRS 097-2-1:2010 Grid interconnection of Embedded Generation is complied with.

Although this NERSA document is considered unclear and unrealistic by municipalities in several important areas, the most significant implication of the document is that SSEG systems under 100kW do not require a license from NERSA. The Regulator has thus acknowledged that the trend to install SSEGs is accelerating and has effectively given municipalities authority to accept such systems without NERSA approval. Systems over 100kW may require licensing from NERSA, although some municipalities are accepting SSEG applications up to 1MW without a NERSA license.

### SSEGs in the IRP

Up to now, the national electricity plan – the Integrated Resource Plan (IRP) of 2010 – has given no consideration to SSEG systems. However, the recent proposed revisions to the IRP explicitly include consideration of SSEGs, partly due to the fact that capital for such systems comes entirely from private sources, unlike Eskom generation installations. The rollout scenario included in the IRP is significant – 10 000 MW by 2010, and it recommends that such SSEG power is purchased by a central buyer to *‘render the municipalities indifferent between their Eskom supply and embedded generators and thus support small-scale distributed generation’* (IRP Update Report 2013, p52). This provision, as well as the NERSA exemption from licensing requirements for those <100kW, is likely to provide a favourable regulatory environment for

SSEGs. However, as noted previously, whether the central SSEG buyer (NETFIT) will be implemented is very uncertain, and it should not be counted on.

## Compliance with technical standards

Most of the technical requirements for SSEG's are covered in the NRS097 series of standards dealing with small-scale embedded generation:

### *NRS 097-2-1: Utility interface (approved & published, but new draft under development)*

Focuses on the interface between the embedded generator and the utility. Device independent. Mainly applicable to grid connected systems interfaced through static power converter technology. Specifies protection and safety requirements and metering arrangements, amongst others.

### *NRS 097-2-2: Type testing (out for comment)*

Deals with product type approval, installation requirements and certificate of compliance on the SSEG customer's side of the meter.

### *NRS 097-2-3: Simplified utility connection criteria for LV connected generators (draft out for comment)*

Deals specifically with the commonly designed unidirectional flow of energy in LV networks, with cumulative impacts of EGs, provide basic acceptance criteria based on network strength and SSEG size, with substation configuration and metering arrangements.

### *NRS 097-2-4: Procedures for implementation & application (not started)*

This standard is yet to be developed.

## Safety and power quality

Grid connected solar PV technology safety and power quality issues revolve largely around the grid-synchronising inverter. This technology has in fact been in the field internationally for decades and is well tried and tested, and there is currently no reason for concern regarding anti-islanding or other safety issues. The national standards are also starting to cover these issues comprehensively, most notably the NRS097 series of standards, which specify the anti-islanding and type-testing requirements for the inverters.

## Impact on low-voltage feeders

In the longer-term municipalities will need to consider the impact of significant numbers of solar PV SSEGs on localised low voltage feeders. Eskom, GIZ and UCT have undertaken work on this issue. However at expected SSEG installation rates these issues are not of concern in the medium-term.

## Reduction of technical losses

SSEGs have the advantage that they reduce technical losses in local distribution networks. Because SSEGs are located where the power is being used ('distributed' generation), wiring distances and thus losses are reduced, and thus overall 'generator-to-end-user' system efficiency of the network is improved, with associated cost reductions.

## Municipal staff capacity issues

There is a concern that SSEGs will require disproportionate attention from overworked electricity department staff well beyond their contribution to the fundamental mandate of these departments – to supply quality electricity services to customers, and to maintain a financially viable operation. Yet in most municipalities the issue does require attention because the alternative is an unregulated proliferation of

SSEGs with resulting power quality and safety issues. It is therefore important that **implementation places the onus on the private sector as far as possible to reduce the burden on the municipality**, including Pr Eng or Pr Tech compliance sign-off.

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## Appendix:

### Potentially useful documents

#### Standards:

- NERSA Standard Conditions for SSEGs (2011)
- NRS 097-2-1: Utility interface (approved & published, but new draft under development)
- NRS 097-2-2: Type testing (out for comment)
- NRS 097-2-3: Simplified utility connection criteria for LV connected generators (draft out for comment)
- NRS 097-2-4: Procedures for implementation & application (not yet available)
- South African Renewable Power Plants Grid Code (SARPPGC)
- Distribution Standard for the Interconnection of Embedded Generation. Eskom, 2008.

#### Guidelines and application forms:

- Guidelines for Embedded Generation, City of Cape Town, 2014
- Application to become an embedded generator – eThekweni
- Application for Connection of Embedded Generation, City of Cape Town, 2014
- ENA G83/1-1 APPENDIX 2 – Application for Connection (Applicable until NRS097-2 templates available)

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This document is an output from a project co-funded by UK aid from the UK Department for International Development (DFID), the Engineering & Physical Science Research Council (EPSRC) and the Department for Energy & Climate Change (DECC), for the benefit of developing countries. The views expressed are not necessarily those of DFID, EPSRC or DECC, or any institution partner of the project.

