CASE STUDY

Small-Scale Embedded Generation in South African municipalities (solar PV focus)[1]

Sustainable Energy Africa

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DRAFT

Background

Due to steep increases in the price of grid electricity 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. In fact many such systems are being installed on businesses and residences, sometimes with and sometimes without going through official approval processes to connect to the grid. In addition to cost considerations, the national power crisis of 2008 led to electricity consumers exploring their options for power supply more widely, further contributing to the adoption of options such as solar PV SSEG systems.

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

Of the 184 Municipalities licensed to distribute electricity, about three have procedures in place to guide prospective SSEG installers regarding system criteria and standards to be followed, and have developed associated tariffs. In general 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. 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 without going through official channels, as has been happening already for several years, albeit on a relatively small scale.

In addition to the above local government issues, there has been ambiguity at the national level regarding SSEGs. The National Energy Regulator has issued incomplete 'guidelines' in this regard, and the overarching national electricity planning framework – the Integrated Resource Plan – is only starting to consider the role of SSEGs in the national electricity supply picture.

[1] Sustainable Energy Africa staff participate in the national SALGA/Eskom working group on small-scale embedded generation, have supported municipalities with standards and guidelines in this area, and have undertaken revenue impact research, in addition to much other relevant work on embedded generation. This case study is thus lightly referenced as the main source of information is the professional experience of the authors.

Internationally, there is significant experience with solar PV SSEG at local level, with Germany being one of the leaders in this field. With the help of a national subsidy, Germany has been installing significant numbers of PV systems for around 15 years, with an installed capacity of 35.6GW at present[2]. Many of these systems (around 15% of the capacity, or 200 000 systems) have been installed on household roofs. On weekends the power supply from PV can reach up to 50% of momentary national power supply. In the USA several municipalities have allocated significant

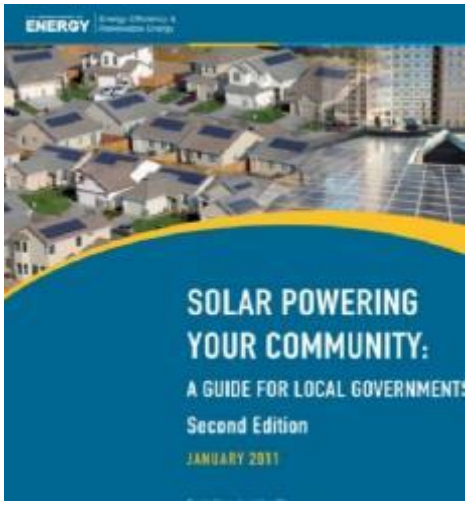

Figure 3: SSEG guide for local government in the USA

Figure 2: San Francisco has developed solar energy tools to help prospective SSEG owners

resources to supporting such rollout (see Figures 1 and 2). However the situation in South Africa is very different from a cost, municipal capacity and network point of view. This case study looks at the situation regarding SSEG in South Africa. It focusses on solar PV SSEG specifically, as this is a dynamic topic in the country at the moment, and explores the current policy, legal, technical and capacity issues around such SSEG adoption. It also discusses how the country can move forward while protecting municipal interests under different policy, regulatory and financial frameworks.

Financial, technical and regulatory situation

Municipal electricity distributors

Of the 228 local municipalities, only 184 are licensed to distribute electricity in their areas of jurisdiction. The remainder of electricity distribution is undertaken by Eskom, the national utility. Although the situation is complicated by the fact that Eskom distributes directly to some customers within many of the licensed municipal distributors for historical reasons, and many of the licensed municipal distributors struggle to remain financially viable, the larger municipalities are all distributors and run viable distribution operations. It is primarily in these areas that the issue of solar PV SSEG is being grappled with and is therefore where the case study will focus. Eskom has also been developing systems to accommodate SSEGs, but this will not be covered in this document as it has limited bearing on municipalities.

The reality of municipal finances

A strong factor affecting how SSEGs are viewed and accommodated in municipalities is the fact that for many municipalities electricity sales are a large source of revenue which cross-subsidises other municipal services, including the provision of services to poor households. Any developments which

[2] Source: *Recent Facts about Photovoltaics in Germany*, March 2014. Fraunhofer Institute, Freiburg.

threaten this revenue therefore meet strong resistance well beyond just the municipal electricity departments, as it affects the very financial sustainability of the entity. Municipalities will therefore set tariffs and other conditions for SSEGs such that they protect this revenue, even at the cost of significantly retarding rollout of SSEGs. Concern around revenue loss has also given rise to some resistance to energy efficiency initiatives within municipalities.

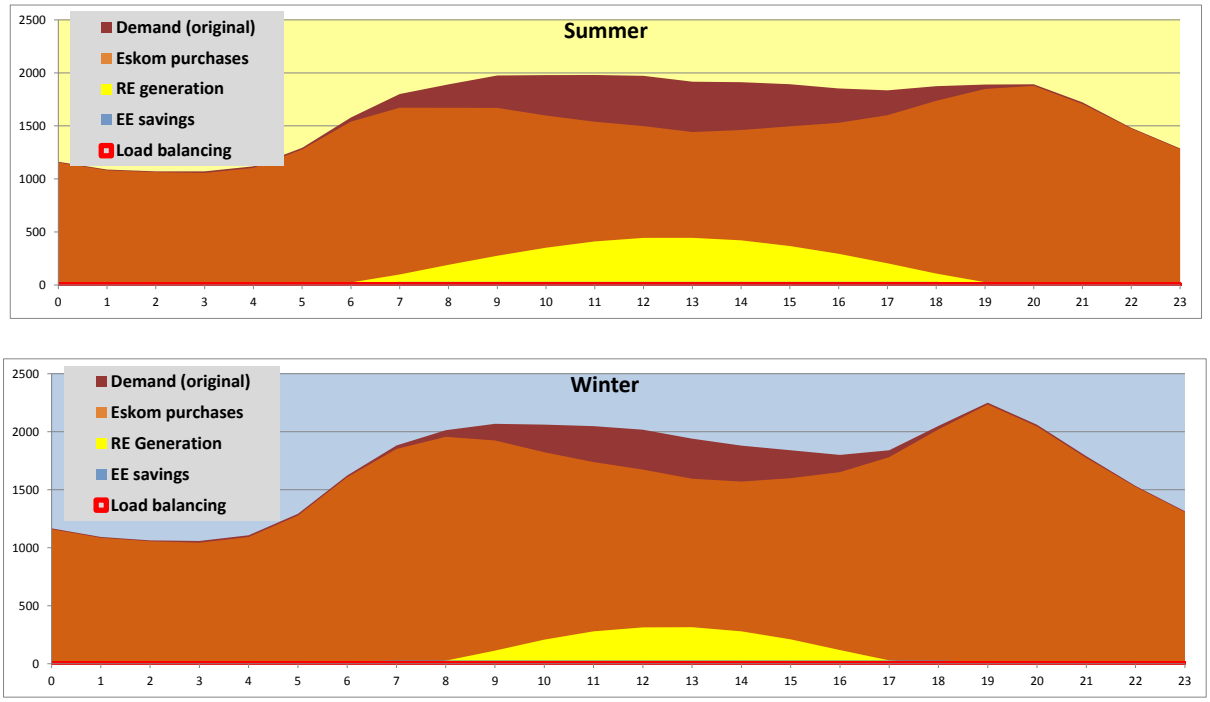

Figure 4: Impact of solar PV rollout (RE generation) on typical city load profile[3]. The dark brown shows the electricity sales losses due to solar PV generation.

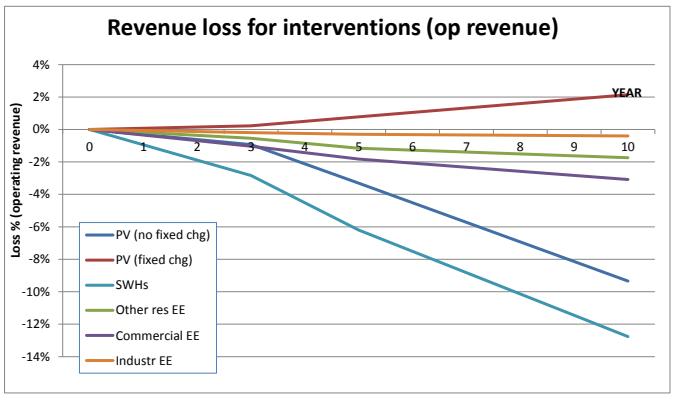

Figure 5: Illustrative municipal revenue losses for different interventions, showing the potentially significant impact of a large solar PV rollout programme

Some external advocates for renewable energy call for municipalities to adopt a different financial model which does not place such a revenue-raising burden on electricity sales, but however theoretically defensible, this is unrealistic even in the long-term, as it strikes at the heart of a deeply entrenched modus operandi and institutional structure within these entities. Having to load other revenue sources to make up the shortfalls would also be politically very difficult to negotiate, and additional funding from national coffers is unlikely.

Financial viability of solar PV SSEG

As mentioned earlier, the fast rising national electricity grid prices and the steady decline in international solar PV prices have brought solar PV into the zone where it can be financially viable for end-users under certain circumstances. In fact many businesses and residences consider that it is

[3] Source: *The Potential Impact of Efficiency Measures and Distributed Generation on Municipal Electricity Revenue*, 2011. Sustainable Energy Africa, for the AMEU Conference 2011.

a good investment currently and some have already installed systems on this basis. A 550kWp system in Cape Town on a corporate head office roof was estimated to have a payback of under 3 years. However, these calculations are often done on the basis that each kWh generated by the PV system saves them money at the rate of the current kWh electricity tariff they are paying. This may be around ZAR1.50 to 2.00 per kWh depending on the tariff category and whether there is a separate service charge or not. But municipalities that have developed SSEG tariffs are in fact only paying SSEG system owners around ZAR0.50 per kWh generated, which pushes solar PV payback periods to closer to 10 years. This SSEG tariff rate is roughly the rate that municipalities pay for bulk electricity purchase from Eskom, and they argue that they are legally obliged to follow this course, as applicable legislation[4] does not allow them to purchase this electricity from SSEG owners for more than the bulk purchase rate. This is in contrast to some countries that actively subsidise renewables such as solar PV. The likely result of these municipal tariff regimes is that solar PV uptake will be significantly slowed, or that it will take place substantially 'under the radar' – with systems being installed without following official channels and thus not going onto the SSEG tariff.

Technical requirements and challenges

Grid connected solar PV technology 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. While this is generally acknowledged, there is still lingering caution amongst some municipalities regarding safety issues – mostly around anti-islanding performance[5]. Previously, South Africa had to draw on international standards to ensure safety and quality of SSEG systems, particularly around the critical areas of inverter type-testing and anti-islanding, but the national standards[6] are however starting to cover these issues comprehensively. From the municipalities point of view there thus should be no significant unresolved technical concerns, as is increasingly demonstrated by the application procedures developed by some municipalities which are now able to outline the necessary technical requirements in detail.

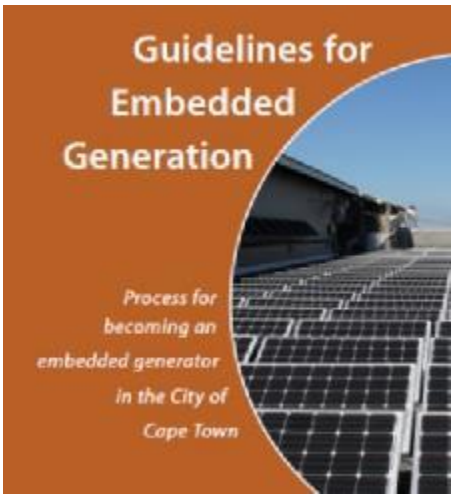

Figure 6: Municipalities are developing procedures outlining technical and other requirements for aspirant SSEG installers (example from Cape Town)

However, these requirements are relatively demanding, and while they are generally considered appropriate for larger installations, for small SSEG installations the costs associated with conformance quickly becomes out of proportion to the system costs. A residence wanting to install a few solar PV panels, for example, upon seeing the design, layout, equipment testing and commissioning requirements placed on them by the municipality, may well not embark on the project, or simply go 'under the radar'.

Another area where technical standards still require attention is for systems over 100kW but under 1MW, which is not covered by a specific standard, although the process to fill this gap is underway.

In the longer-term municipalities will need to consider the impact of significant numbers of solar PV SSEGs on localised low voltage feeders. The impact on voltage and substation operation of

[4] The Municipal Finance Management Act requires municipalities to procure services at the lowest cost.
[5] Anti-islanding: the ability of the inverter to isolate from the distribution network when the network power is off, thus ensuring the safety of technicians working on the network.
[6] Most notably the NRS-097 series of standards.

significant reverse power feed, for example, needs to be better understood. Although work in underway to clarify these issues, at expected SSEG installation rates South Africa remains many years away from these concerns becoming problematic.

Reduction of technical losses

SSEGs have the advantage that they reduce technical losses in local distribution networks. Such losses are typically around 5% or more[7]. 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. This can be a significant benefit of SSEG rollout.

National regulatory environment

All generation capacity in the country requires a license from the National Energy Regulator of South Africa (NERSA) in terms of the Electricity Regulation Act of 2006. In 2011 NERSA issued a document entitled *Standard Conditions for Small Scale (less than 100kW) Embedded Generators in Municipal Boundaries*, which was intended to provide guidance around licensing and other requirements from the SSEG owners and from the municipalities regarding these systems. Although it 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 by default do require licensing from NERSA.

Up to now, the national electricity plan – the Integrated Resource Plan (IRP) of 2010 – has given no consideration to SSEG systems. Given that new generation capacity licensing requires conformance with the IRP, this led to reticence to accommodate these systems on the part of NERSA and the municipalities. 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.

[7] Source: Fourie, 2004. *A strategy for the management of energy losses in a local electricity distribution network.* University of Pretoria.

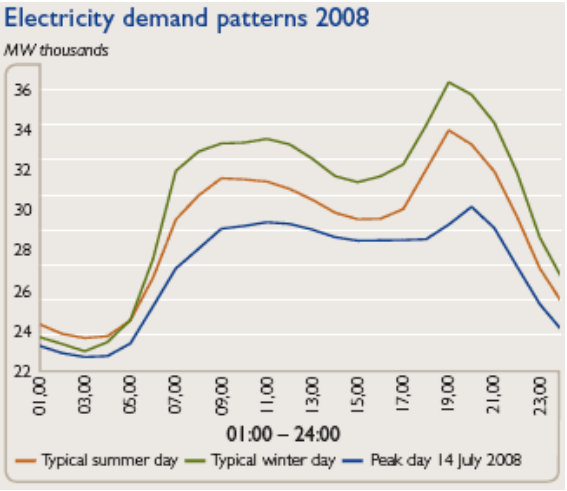

Figure 7: The evening-peaking South African load profile – driven largely by domestic evening power use

The role of renewable energy such as solar PV SSEG does have limitations, however, in that the load profile does not match the national 'evening peaking' profile well, and the availability of power is not guaranteed at any particular time (e.g. cloudy days). It therefore needs to be paired with other 'fast response' generation options from a national perspective, which increases the cost of the total system.

Institutional capacity within municipalities

While municipalities recognise that they need to be able to accommodate SSEGs, partly because they will otherwise be installed 'under the radar' and partly because they are often part of an overarching city move to sustainable energy and low carbon development, they typically have limited staff capacity to deal with this area. They are short-staffed and even struggle to fulfil their basic mandate of providing adequate electricity services to consumers. Mounting imperatives such as those associated with the electrification of informal settlements and maintaining and repairing ageing network infrastructure place existing staff resources under pressure. They are now faced with the prospect of needing to accommodate potentially thousands of SSEGs over the coming years, with associated processing of application forms, queries from aspirant SSEGs, fault response, inspections and even dispute engagement where it is unclear whether the responsibility for malfunctions lie with the SSEG installer or the city. There is a concern that SSEGs will require heavily disproportionate attention from overloaded 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.

Current initiatives of significance

Private solar PV SSEG installations

Private household and business SSEG installation numbers have been accelerating over the past two years in particular, and several systems of over 500kW now exist around the country, and a few of over 1MW are in place (although these have not always been allowed by municipalities to reverse-feed into the grid because the necessary standards and approval procedures are not yet finalised).

Municipal and other government solar PV SSEG systems

Several municipalities are installing solar PV SSEGs on their facilities, and others have plans to do so in the near future. Cape Town has installed a 10kWp[8] and 20kWp system on their buildings, and is currently awarding a tender for another 80kWp system. Ekurhuleni is issuing a tender for two 150kWp systems on municipal buildings, and eThekwini is intending to install around 500kWp in the next two years. 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[9]. This seems very ambitious and would require approvals from NERSA and local electricity distributors before proceeding. It is unclear

[8] kWp (kilowatt-peak) is the peak rated power (roughly equivalent to the output in the middle of a sunny day) of a PV system, and is often used interchangeably with 'kW' for PV systems.

[9] Source: *The Leading Edge*, July 2013. Institute for Futures Research, University of Stellenbosch, Cape Town.

whether this necessary preparation has been undertaken, and therefore whether the programme is feasible.

Single buyer model

Eskom has undertaken some background analysis on a model whereby a central national purchaser reimburses SSEGs or municipalities directly for the power they generate. This is linked to the approach recommended in the current revised national electricity plan, the IRP, and would avoid any impact on municipal revenue where SSEGs are located within municipal distributor areas. The model is attractive for municipalities and could better promote SSEGs through the provision of higher tariffs than municipalities offer, but is still in proposal stage, and institutional and financial details thereof are far from finalised. It is therefore unclear whether and when this might come into effect.

Leasing model

A private consortium has announced the imminent launch of a leasing model for solar PV SSEG systems[10]. It will be available to industrial, commercial, and residential customers, will require no upfront payment, and customers will pay less for power from the SSEG than for grid electricity. While this seems very promising for SSEG rollout, municipal observers point out that there are potential licensing and legal complications, such as whether generation from a system for use by the property owner but not owned by the property owner is legally digestible under current frameworks.

Current tensions and potential way forward

Attractive conditions for SSEG installers: avoiding SSEGs going 'under the radar'

From the potential SSEG installer's point of view, there are two big considerations which influence their decisions. Firstly, the demands of compliance with municipal requirements and the cost associated with this, and secondly the tariff regime of the municipality and thus the payback of the SSEG system. For larger systems, the compliance demands are not considered inappropriate, and comprise a relatively small portion of the total costs. For small systems however, such as those that a single residence might want to install, associated costs and effort are likely to be prohibitive. The tariffs being offered may also tempt aspirant SSEG installers not to follow official channels and rather remain on non-SSEG tariffs, as SSEG tariffs reduce payback significantly even though they are completely defensible from a municipal viewpoint.

Potential way forward:

- *Offering more attractive tariffs for SSEG systems*: This is not feasible from a municipal point of view because it would lead to under-recovery of the cost of network availability for these customers. Municipalities could not easily justify the resulting subsidy given the financial pressures that they are under to keep basic municipal services functional. Any such subsidies would need to come from the national level, such as via the 'single buyer' model being discussed presently.
- *Reducing the compliance complexity for small SSEG systems*: Compliance inspection and sign-off could be undertaken much more simply (and cheaply) by enabling registered electricians to do this, and providing a training course for them to develop the necessary competence in this area.

[10] Source: *Lease Finance Initiative for Rooftop PV*, 13 March 2014. ESI-Africa.com

Attractive conditions for municipalities: avoiding revenue loss, technical complications and demands on staff

Technical standards need to be upheld from a safety and power quality perspective. These standards are necessary and are being finalised nationally, and a number of municipalities have procedures in place outlining these and other requirements for SSEG applicants. This area therefore does not seem to be a constraint.

Municipalities are also instituting tariffs to avoid revenue loss. Although such tariffs reduce the savings from the SSEG systems as discussed in earlier sections, they are consistent with the principle of cost recovery and they avoid cross-subsidisation of such systems from other user categories.

Municipal electricity departments would, however, struggle to handle large quantities of applications from SSEGs given their generally understaffed situation. This would also result in significantly more ongoing fault logging and other technical enquiries from SSEG users/owners. Even the installation of a few hundred SSEGs may result in such staff capacity problems.

Potential way forward:

- *Monitor electricity department staff capacity situation regarding SSEG engagement*: It is not clear when or whether this issue will become a problem. It is possible that SSEG rollout will not accelerate, and thus demands placed on staff will be manageable. At this point it needs to be noted as a potential future concern and monitored, and an action plan formulated should it become necessary.

The national point of view: promoting renewable energy SSEG, but ensuring an acceptable power source mix to meet the national load profile

National government is interested in promoting renewable energy, as reflected in the Renewable Energy White Paper (2003) and the Climate Change Response White Paper (2011). SSEG systems are now recognised as an attractive option for the country as they are completely privately funded and costs are not factored into the national tariff – unlike the costs of the large-scale national renewable rollout programme (although this may change is the 'single-buyer' model is implemented for SSEGs). They also reduce overall technical losses of the network because of their proximity to the end-user. For these reasons they are considered in the national electricity plan. However, mass rollout of SSEGs may be unlikely in the face of the tariff regimes that municipalities are obliged to impose on such generation. If it is sufficiently in the national interest to accelerate such rollout, some form of incentive is likely to be necessary.

The national electricity planners will need to ensure that the rollout of SSEGs does not compromise the generation mix to meet the national demand profile. Solar PV SSEG generation has a relatively low capacity factor (i.e. the power is only available for 20% of a 24-hour period on average) and is variable to some extent, and so dispatchable generation options may need to be in place to compliment this, which will have an influence of the cost of the national system. However, the national system is being configured such that it can handle several thousand MW of variable renewable energy generation plant[11]. Until SSEG systems reach a total capacity of several hundred MW at least, impact on the national generation mix is unlikely to be a significant constraint.

Potential way forward:

- *SSEG incentive from national level to be developed*: If SSEG is to play a significant role in the national generation picture, it is likely to need an incentive from national

[11] The national renewable energy rollout programme is including at least 3000MW installed capacity of large-scale wind and solar generation plant.

government, as municipal tariffs will not fulfil this function. The currently proposed 'single buyer' model has this in mind.

Conclusion

It should be borne in mind that significant interest in SSEGs is relatively new in the country. Also, municipalities are by nature conservative. Given this situation, and the fact that municipalities are under-capacitated as well as the serious implications for not proceeding with due diligence, progress to integrate SSEGs in to municipalities and into the national generation mix seems reasonable. The tariff and technical conditions being applied to SSEG systems in municipal areas appear necessary in general, except in the case of small SSEG systems, where a simplified compliance process is needed. However, the municipal tariffs will not result in rapid adoption of SSEG options, and this factor, together with the demanding compliance procedures for small systems, is likely to lead to a proportion of installations taking place 'under the radar'.

If solar PV SSEGs are to play a significant role in the national generation picture, it is likely that support will be needed from the national level. The 'single buyer' model is intended to provide such support. Establishing this model is arguably the single most critical policy decision regarding SSEGs at a national level, and is likely to change the playing field considerably. Should it be put in place, SSEG implementation is likely to increase by an order of magnitude, and 'under the radar' installations are likely to be minimised (depending on the tariffs offered). However, alongside this rollout, the concerns around municipal capacity will need further attention. This will need to be monitored.