Nelson Mandela Bay Municipality, South Africa

Embedded energy generation experience in a South African metropolitan municipality

Nelson Mandela Bay Municipality is a leader in small-scale embedded energy generation in South Africa. From the outset, the Municipality has opted to focus on the contribution that small-scale embedded generation can make towards achieving key constitutional mandates such as economic growth and development, sustainable service delivery, and ensuring a safe and healthy environment.

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Summary

In 2008, the Nelson Mandela Bay Metropolitan Municipality (NMBM), which unites the cities of Port Elizabeth and the towns of Uitenhage and Depatch, spearheaded the piloting of small-scale embedded energy generation in South Africa: they connected a small-scale wind and solar energy generation pilot site to the energy grid using a simple system for net metering. Subsequently, in September 2011, the National Energy Regulator of South Africa (NERSA) developed and approved the Standard Conditions for Small-Scale (<100kW) Embedded Generation (SSEG) within Municipal Boundaries.

Embedding small-scale generation is inherently a local matter; as such, municipalities play an important role in terms of creating the infrastructure necessary to enable and facilitate the connection of small-scale renewable energy production to the electricity grid. In addition, the municipality regulates the practice to ensure the optimal reticulation of electricity (distribution network).

Although conscious of the fact that facilitating SSEG would not be financially profitable for the municipality, a long-term perspective motivated NMBM to pursue it further. By facilitating the uptake of embedded generation, NMBM is laying a foundation for low-carbon urban growth, economic and socio-economic development, and improved energy security through the diversification of the local energy mix. Moreover, they are working alongside citizens to do so. Therein, SSEG allows NMBM to drive economic growth and development, deliver services to the community, and promote a safe and healthy environment for residents.

Meeting energy demand with small-scale renewable energy

In 2007, South Africa's electricity demand exceeded supply. This prompted Eskom, the state-owned power utility, to implement the practice of load shedding (the planned interruption of service in targeted areas) in order to protect against destabilization of the national electricity grid. This challenging circumstance, together with growing concerns about rising greenhouse gas emissions and global climate change, has generated increased interest in the viability of renewable energy in South Africa.

Access to reliable energy is a key indicator for quality-of-life, and it is inextricably linked with socio-economic well-being. Consequently, there is considerable interest in the potential benefits of small-scale renewable energy, such as: additional generation capacity; reduction of transmission losses; potential for enhancement of grid stability; and mobilization of additional small-scale investment with broader participation.

Facts & Figures

Population / Land area
1,15 million / 1, 950 km² (2014)

Municipal budget
$722,000 million USD (2014)

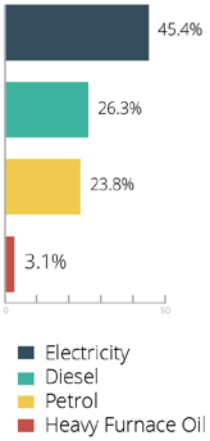
Greenhouse gas inventory
Yes (2012)

Total GHG emissions for area
5.2 million tCO_2e (2012)

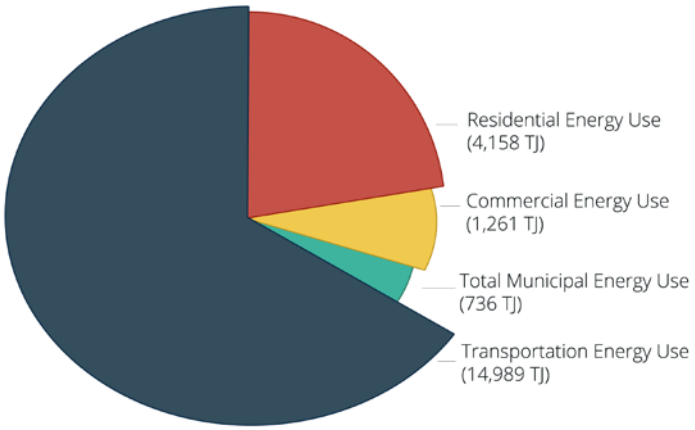
Nelson Mandela Bay Metropolitan Municipality has been a member of ICLEI since 2006

Nelson Mandela Bay's context for alternative energy

Energy use by carrier in NMBM (2012)



Energy use by sector in NMBM (2012)



Urbanization is correlated to increased energy consumption and in 2008, the demand for electricity in NMBM was greater than the available supply. This trend was seen throughout urban areas in South Africa; in response, rolling blackouts through load shedding and a national mandate to reduce energy demand by 12 percent were introduced by Eskom.

Of NMBM's 1.15 million inhabitants, 97.7 percent live in urban areas and 12 percent live in informal settlements. In consideration of its significant urban population (and its annual growth rate of 1.38 percent), the NMBM local authority has made renewable energy production a major aspect of its local economic development and social welfare strategy.

Coal is the predominant method for energy production in South Africa, and its subsequent distribution is a major source of municipal revenue. Because of its prominence, the interruptions to energy services that occur with load shedding brought about a greater awareness of the total cost of electricity and the limitations in regard to coal-fired power. The increased demand for energy, and lack of available supply, has seen energy costs rise. This has generated greater dialogue about the need for a move to renewable energy sources and increased energy efficiency. It has also, however, driven many of NMBM's inhabitants to (sometimes illegally) seek out unregulated sources of energy.

As consumers began to desire and pursue unregulated sources of energy, it became apparent that the longer NMBM waited to regulate these sources, the more difficult it would be to manage them effectively. Consequently, NMBM has significantly developed its renewable energy infrastructure. This decision is further motivated by the belief that: renewable energy will be less expensive in the longer term; will create investment opportunities and platforms for local economic development; and will improve social welfare in the municipality.

Embedded generation

Embedded generation refers to the generation of electricity by residents, business or industries via grid-connected devices that make use of renewable energy resources. Solar is the most common source due to ease of installation and the nominal maintenance required, however wind and bio-gas are also viable options.

SSEG in NMBM is performed by private residents and small -to-medium sized businesses. At the small-scale, rooftop solar PV is the most financially viable option. Wind is mostly limited to industrial areas, as there are issues regarding safety, noise, and zonation when considering residential areas.

Small-scale embedded generation: An essential component in low carbon urban development

In 2005, motivated by the South African National Government's White Paper on Renewable Energy (2003), NMBM started investigating renewable energy possibilities for the municipality. In 2008, NMBM was granted approval from the National Energy Regulator of South Africa (NERSA) to pilot a small-scale embedded generation residential site. The pilot system consisted of both wind (1kW) and solar (initially 1kW, later increased to 5kW) and used a simple system for net-metering. At the time, the conclusion was that small-scale embedded generation, although technically feasible, was not financially viable. However, the cost of renewable energy generation decreased considerably in the years following 2008. This, combined with the increase in electricity tariffs, made pursuing small-scale **embedded generation** an increasingly viable option.

In 2010, NMBM presented their experience with SSEG to NERSA. With the benefit of NMBM's pioneering input, NERSA subsequently developed the Standard Conditions for Embedded Generation within Municipal Boundaries in September 2011. Under these conditions, which remain under review, providers with generation systems smaller than 100kW can produce electricity in the absence of a generation license. Following this incentive, the NMBM Electricity and Energy Directorate recommended

in May 2012 that their colleagues in NMBM Infrastructure, Engineering and Energy Committee revise the previously proposed Green Economy Business Plan to incorporate embedded generation. On 29 June 2012, a Mayoral Resolution was signed by the Executive Mayor. The Resolution stated that the Electricity and Energy Directorate could develop the process, requirements, specifications and standards that producers must adhere to in the NMBM Application for the Connection of Small-Scale Embedded Generation (SSEG) and Interim Requirements for SSEG.

This process has required initiatives directed at building operational capacity and raising awareness in the region. To these ends, NMBM Electricity & Energy: Projects sub-directorate has made presentations to business leaders interested in the implications of SSEG for business in NMBM.

To get the ball rolling, preceding a cost of supply of electricity study (performed in 2012-2013), NMBM set the export price of electricity into the grid equal to the import cost. The only additional costs to the generator were that of the procurement and installation of the bi-directional meter and web-based modem: 190 USD for a one-phase-meter/modem and 365 USD for a three-phase-meter/modem. These bi-directional meters allow for the **net-metering** of electricity consumption imported from the grid, as well for electricity produced and exported back to the grid by the local small-scale generator.

The four-step process for becoming a small-scale generator is as follows:

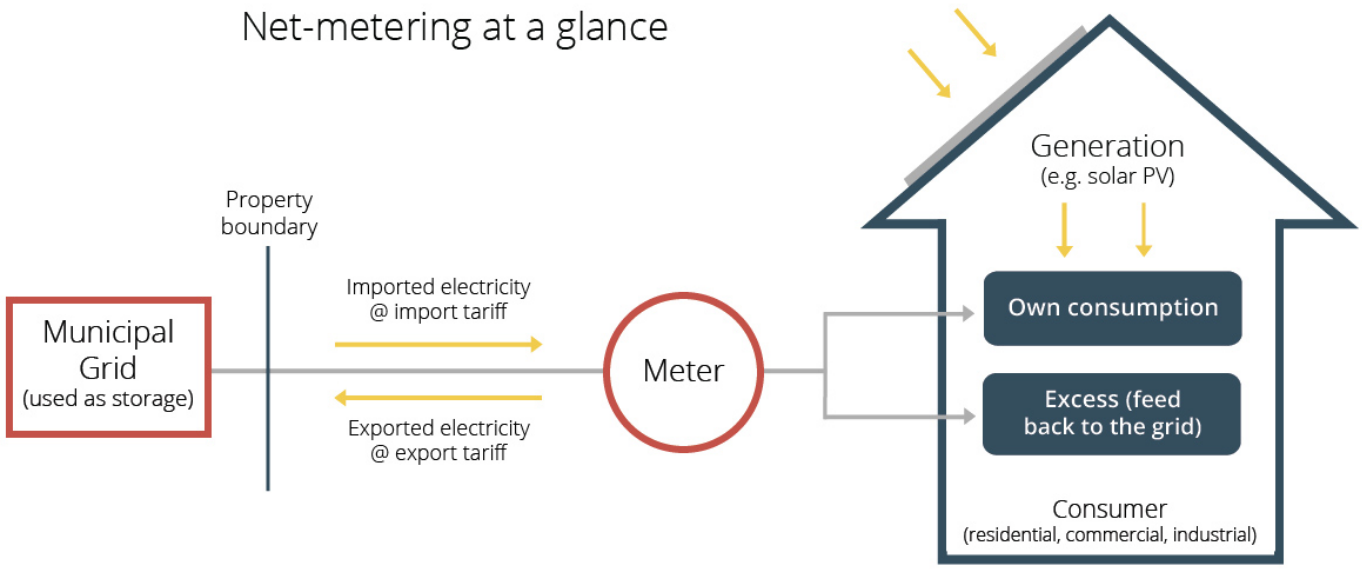
- The generator determines the size of the system in accordance with standards for compliance and performs the installation. The parallel connection of any generator to the electrical grid has implications for the safety of municipal staff, the public, and the user of the generator.
- The installation needs to be approved by either a professional electrical engineer or electrical technologist, who must then complete a Certificate of Compliance. Any system connected to the grid must adhere to legislation, standards and normative references, all of which is contained in NMBM's Interim Requirements for SSEG.
- The application form, once approved, is submitted to Customer Care by the generator, along with the application fee. Once the application has been entered into the system, it is passed on to NMBM Electricity & Energy Metering Division by Customer Care. On receipt of the application and CoC, NMBM Metering division installs a web-based net meter on-site and connects the installation to the grid.

Net-metering

There is no standardized definition for net-metering; thus, the term will be used in a different context depending on the country.

For South Africa, net-metering refers to a billing mechanism that allows small scale generators to be rewarded for energy that they produce and export into the municipal grid. The bill received by a generator is for the net quantity of energy that was consumed from the municipal grid (the total imported from the municipal grid minus the total exported into the municipal grid) over the monthly billing period.

The financial benefit provided by NMBM for exported electricity is capped to the value of imported electricity (no cash payment for surplus production is offered). However, in the event that a generator produces a surplus of electricity, they are permitted to sell it to an approved trading company outside of the municipality.



Schematic: Original by Aurelie Ferry (SALGA), modified by Elana Keef (Afri-Coast); Graphic Design: Margaret Keener (ICLEI WS)

Intercity comparison: eThekwini

Motivated by the need to provide a stable and continuous electricity supply, reduce transmission losses and construction costs, relieve stress on the national grid, and contribute towards achieving national renewable energy targets, the eThekwini Municipality gave their full support to SSEG. The application form for embedded generation lists the standards that must be complied with, which are similar to NMBM and the City of Cape Town

eThekwini Municipality have developed the Residential Embedded Generation Tariff – Scale 15. Imported energy is charged at 115.32c/kWh (excl. VAT) and generated energy exported at 74.96c/kWh, which is 65% of the imported cost. A monthly service charge of R100.00 is applied if the net consumption is less than 300kWh. The tariff is, however, yet to be approved by NERSA.

- The generator is then provided with a unique password to enable viewing of consumption via NMBM's online energy management system. The net-metering is calculated over a period of one calendar month. Both the amount of electricity imported-from and exported-to the grid is indicated on a generator's monthly municipal bill.

In March 2013 the first small-scale generation system, a 3.8kW solar PV ground mounted system, was installed and officially connected to the grid.

NMBM is facilitating embedded generation, through minimal cost requirements and an accessible application process. The municipality covers 50 percent of the cost of the bi-directional meters. Moreover, a tax incentive for businesses, which allows organizations to depreciate renewable energy assets over three years (year 1: 50%, year 2: 30%, year 3: 20%) is in place. NMBM maintains a one-to-one ratio between import tariff and export tariffs; this sets NMBM apart from other municipalities in South Africa, which offer a reduced return on the tariff for electricity exported back into the grid through SSEG.

Tariffs for net-metering

Import tariff		Export tariff	Service charge
c/kWh	c/kWh incl. VAT	c/kWh incl. VAT	R/month incl. VAT
0-350 kWh	78.3	78.3	
350-600 kWh	86.1	86.1	
600-950 kWh	142.7	142.7	
950+ kWh	157.9	157.9	323.37

Costs and financing

NMBM recognizes that electricity cannot remain the primary source of municipal revenue, and that sustained investment into Nelson Mandela Bay is very important. Thus, NMBM is currently not concerned about the loss in revenue experienced with embedded generation, which explains the one-for-one offset, wherein generators export electricity at the same tariff at which they import electricity (regardless of the generator being residential, commercial or industrial).

Instead, NMBM has incorporated embedded generation into a long term perspective. It is focusing on maintaining control over the grid, enabling economic development and investment opportunities associated with embedded generation, and establishing Nelson Mandela Bay as renewable energy manufacturing hub.

At present, standard domestic and commercial tariffs are applied as is, with only adminstrative charges and a service charge for export exceeding 950 kWh being levied. The tariff structure currently applied by NMBM does not reflect the real cost of

Organizations involved in energy production in South Africa

The **Department of Energy (DoE)** is responsible for energy policy in South Africa, and is the custodian of the IRP - Integrated Resource Plan for South Africa.

The **National Energy Regulator of South Africa (NERSA)** was established in 2005, subsequent to the formal proclamation of the National Energy Regulator Act, 2004 (Act No. 40 of 2004), for the purpose of regulating the electricity, piped-gas and petroleum pipelines industries in South Africa. In terms of the Act, NERSA sets national best practice standards for the general functioning and conduct of all actors in the electricity, pipe-gas and petroleum pipelines industries. NERSA is tasked with implementing government energy policies, plans and acts.

Eskom is the South African electricity utility and currently provides approximately 95% of the country's electricity. It is the primary generator of electricity, and is responsible for all transmission and some of the distribution within South Africa. Eskom became a public company (state-owned enterprise) in July 2002, and is currently the primary producer of electricity within South Africa. Eskom has many different tariffs and tariff structures which are applied to different customers and are updated annually.

embedded generation, as it does not address aspects such as grid maintenance and administration costs. In order to ensure a sustainable platform for energy investment, distributing entities need to maintain the infrastructure, and generators cannot expect to use the electrical grid as storage without contributing to its maintenance and upgrade. NMBM will amend the tariffs and fees in the future, but not until a follow-up tariff study and cost analysis has been performed.

Results

To date, 27 embedded generation systems have been connected to the NMBM grid, with 25 of these systems being smaller than 100kW. These systems compliment the existing NMBM renewable energy framework; NMBM also allows generation systems of 100kW to 5MW to connect to the grid, provided they are licensed by NERSA.

The primary direct impact of the NMBM facilitating embedded generation is the retention of control over the electrical grid through regulated grid connection. Generators are going to connect to the grid, whether regulated or not. Permitting and facilitating embedded generation, and making the process simple and cost effective, is encouraging compliant grid connection. It is foreseen that SSEG will positively impact future economic development and investment opportunities, and represents a step towards the overarching goal of establishing Nelson Mandela Bay as a renewable energy manufacturing hub.

An unexpected outcome of the process has been the improvement of the relationship between consumers and the municipality. The local community (both residential and business) is becoming increasingly involved in energy generation, while the NMBM and independent generators continue to take positive steps towards a cooperative future: a significant portion of Nelson Mandela Bay's electricity is now generated by localized renewable energy generation systems of varying sizes. If the demand for distributed generation becomes too big and/or the cost of renewables dips below that of Eskom, municipalities will be able to buy from large-scale private generators such as **Amatola Green Power** (who are involved in the purchasing of surplus energy generated through SSEG). This will necessitate greater levels of cooperation between generators and the NMBM.

Lessons learned

The application and approval process could be easier for potential small-scale generators to navigate. There is no single coordinator to oversee the process from application to connection; instead, multiple entities are involved at the various stages. There are also limitations in terms of staff capacity, particularly with regards to compliance monitoring. NMBM plans to develop a formal internal procedure for receiving and processing applications for SSEG, but has no staff to undertake this. In the interim, NMBM have appointed a consultant to manage the process and do the required monitoring.

The relationship between electricity as a commodity purchased as opposed to something that can be produced is not fully understood by members of the community.

Amatola Green Power

In 2013, NMBM signed a 15 year wheeling agreement with Amatola Green Power (AGP) which allows AGP to buy and sell renewable energy within Nelson Mandela Bay, using the NMBM's grid infrastructure. Nelson Mandela Bay is currently the only city in South Africa within which such an agreement exists. Generators thus have the option to trade any excess electricity through AGP.

Amatola Green Power (AGP) is the first private sector energy trader licensed by NERSA to buy and sell renewable energy in South Africa. AGP operates independently from Eskom and from local municipalities and trades in clean energy by connecting willing buyers to willing sellers. AGP is therefore not limited to the Eskom price of electricity.

AGP, as a trading platform, enables a generator to size their generation system according to their peak winter demand, which is the most expensive electricity, or according to future needs, knowing that any excess electricity generated can be sold through AGP. In doing so a generator mitigates a potential loss on a renewable energy investment.

Photo: D. Liebenberg

Inverters and generation control from a small-scale project installed in NMBM (2008)

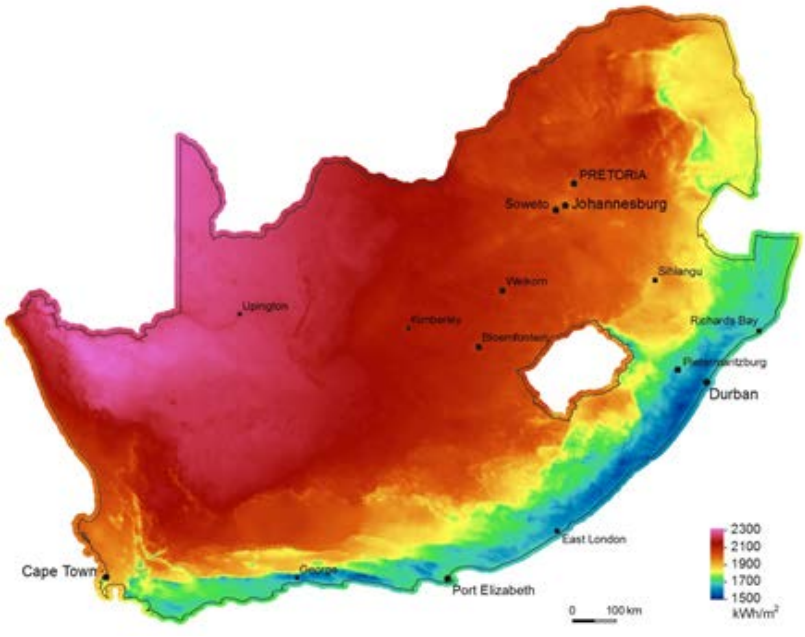
There are concerns and fears around small-scale embedded generation as it is still very new, as well as a lack of education and awareness of the technical complexities, thereby making it difficult for the average person to understand. Inroads for raising awareness have been made by the municipal government through presentations to interested parties.

Uptake of SSEG can be inhibited by persisting short term perspectives on capital expenditure. Many residents and businesses have short term perspectives (around 3 years) in regard to capital expenditure, whereas renewable energy systems require 7 to 12 years for the initial investment to be paid-back by the savings on electricity purchases. Organizations that can benefit from the process are thus reluctant to pay the initial capital outlay. For many businesses, electricity is not yet a big enough contributor to input costs to motivate immediate action. This might change if load shedding and electricity outages become more frequent.

Community comes first in NMBM. The tariff and fee structure for embedded generation is such that the long-term benefit gained through collaboration in the electricity supply within NMBM is of greater value than the loss in revenue and costs for maintaining the local grid.

A clear national framework for SSEG would facilitate work done by municipalities. The possibility of local authorities having more control over local energy supply and planning would give independent power producers fair access to both the national and local grid. For this to occur, a favorable regulatory environment would need to be established at a national government level. Notwithstanding deregulation, a decision support tool for municipalities, developed by national government, highlighting the 'pros' and 'cons' of SSEG, could facilitate the roll-out of SSEG by municipalities as it provides the security of knowing that decisions are within legislative parameters.

In order to ensure the effective roll-out of embedded generation within Nelson Mandela Bay, closer cooperation between the various municipal directorates and/or sub-directorates (i.e. Building Inspectorate, and Air Pollution & Noise Control) is required. NMBM should aim to resolve any process-related issues during this initial stage while the uptake is still relatively slow, so that a well-established and robust procedure is in place when the rate of SSEG uptake increases.



Irradiation map for South Africa indicating suitability for solar energy throughout the country (blue [low] to red [high]).

Map: SolarGIS

The Urban-LEDS Project

An Urban Low Emissions Development Strategy (Urban LEDS) defines a pathway to transition a city to a low emission, green and inclusive urban economy, through its integration into existing city development plans and processes.

The Urban-LEDS project (March 2012 - March 2016), funded by the European Union, was jointly implemented by UN-Habitat and ICLEI. It supported local governments in emerging economy countries (Brazil, India, Indonesia, South Africa) and in Europe to transition to urban low emission development using ICLEI's GreenClimateCities methodology, comprehensive process guidance, to integrate low emission strategies into all sectors of urban planning and development.

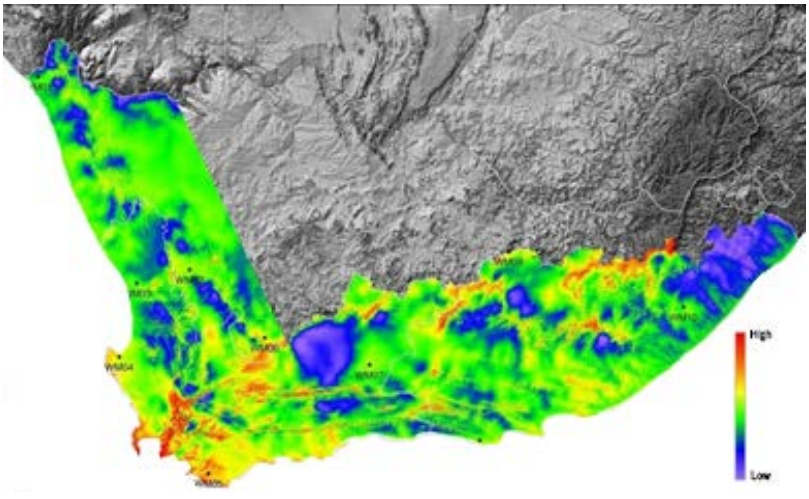
The ICLEI Africa Secretariat has been working with NMBM through the Urban-LEDS project to develop a Greenhouse Gas Inventory, and facilitate staff attendance at professional development courses, and at ICLEI facilitated training and other events. NMBM also hosted the first Urban-LEDS international networking seminar in 2013. NMBM is also a national finalist in the 2014 - 2015 Earth Hour City Challenge.

For more information, please visit: **http://urbanleds.iclei.org/**

Replication

In addition to assessing the potential capacity for solar and wind generation, there are important aspects that other municipalities need to consider before allowing SSEG.

- **Understand the financial implications.** A municipality must calculate the real cost of embedded generation in order to ensure the recovery of these costs, and determine the tariffs accordingly.
- **Guarantee that the municipality's billing system can accommodate the necessary credit adjustments.** Moreover, a municipality should make sure that there is an appropriate metering system in place, and be prepared to provide systems for measuring and monitoring the contribution of SSEG to total energy supply.
- **Ensure that installations are compliant with relevant standards and requirements.** Compliant, individual embedded generation systems should have little or no impact on the grid. There is, however, still uncertainty as to the cumulative impact that embedded generation systems will have if multiple systems are generating simultaneously. It is important to be aware of the technical implications associated with connections to the grid, especially in terms of voltage fluctuations outside of acceptable limits and harmonics, which could damage both the electrical appliances and equipment of consumers and the municipal grid infrastructure, and to ensure that this is addressed before approving an installation.
- **Be aware of potential risks, and implications for capacity.** In light of the current national embedded generation context (from a legislative experience and capacity point of view), if a municipality wants to go beyond granting permission, to encouraging the uptake of SSEG and facilitate embedded generation within their municipal area, there will be risk involved. This includes, but is not limited to, the cumulative impact of multiple generation systems exporting electricity onto the grid, and financial risks associated with potential additional network maintenance and upgrades.
- **Have a strategy in place for addressing the use of inferior/unlawful equipment.** In the case of NMBM there is an Electricity Supply By-Law which authorizes NMBM to disconnect any installation that is deemed illegal according to the by-law.



Map: WASA Project

Main wind resource areas in South Africa indicating suitable location for electricity generation by wind (blue [low] to red [high])

Intercity comparison: City of Cape Town

The City of Cape Town (CoCT) approached NERSA for their stance on SSEG at a similar time to the NMBM. Despite this, the CoCT has initially not actively promoted SSEG. This decision has been based on the view that there is no clear legal mandate that allows municipalities to purchase excess generated electricity from small scale embedded generators, and because of the loss of revenue associated with decreased electricity sales.

The CoCT has since developed a comprehensive list, similar to the NMBM interim requirements, for small scale embedded generation that must be complied with when connecting a generator to the municipal grid. The CoCT limits the maximum generator power output as per the NRS 097-2 specifications, and consumers with embedded generation must be net consumers over a rolling period of 12 months.

The SSEG tariffs (as per the CoCT's website on 29 September 2014) for export of electricity to the grid (i.e. generation) are significantly lower than the import tariffs (i.e. for consumption of electricity). For residential customers, the import tariff is 95.76c/kWh (excl. VAT) and the export tariff 49.72c/kWh (excl. VAT). An additonal daily service charge of R11.43 is added. For commercial customers, the import tariff is the current tariff that a customer is on, provided that they are on a tariff with a demand charge, and the export tariff 49.72c/kWh (excl. VAT).

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SALGA
South African Local Government Association

nelson mandela bay MUNICIPALITY

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