SAMSET – Supporting Sub-Saharan African Municipalities with Sustainable Energy Transitions

Energy and urbanisation in South Africa: Context report and literature review

Sustainable Energy Africa

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Purpose of the document

The document is not intended to be a traditional literature review, but is rather aimed at being a resource document for those interested in sustainable energy in South Africa, and in particular being a resource for the SAMSET project. It thus provides a context for the energy and urbanization situation in South Africa, and then draws on a range of literature to look at the status of planning and implementation of sustainable energy options in urban areas. Specifically, it aims to answer the following questions in order to inform the way forward for sustainable energy transitions at local government level:

- *What are the key issues (i.e. problems and opportunities) around sustainable energy in urban South Africa?*
- *What relevant plans are in place or approaches have been tried (if any) regarding sustainable urban energy, and to what effect?*
- *What are appropriate approaches going forward around sustainable energy transitions at local government level?*

The context

Key factors that have shaped South Africa's urban energy picture

The urban energy transition in South Africa has been strongly influenced by the following factors over the past decades, as witnessed in documents such as the National Development Plan (NDP 2011) and the discussion document: Towards an Integrated Urban Development Framework (IUDF 2013).

1. **Sprawling, low density cities** inherited from days when transport costs were low, land more freely available, and the interests of the wealthier white car-owning population were being served above the majority of the population. This has resulted in energy inefficient cities where transport energy demands, and thus expenditure, are high, where dependence on private vehicle use is widespread, and where **infrastructure costs to provide adequate public transport are prohibitive**.
2. **Apartheid-based urban layout**, with poor historically black communities located on marginal land. Although service delivery programmes have prioritised these areas since the advent of democracy in 1994, the spatial aspects of the apartheid urban form change slowly and still prevail. In fact some argue that it is now harder to change this inequity due to its being entrenched by the infrastructure investment programmes which targeted these areas (IUDP 2013 p16).
3. **A steady urbanization rate** (1.2%pa) and a **growth in informal housing** because the state housing programme has not been able to keep up with the demand. Currently 13.6% of the population live in informal housing, with around 1.96 million informal households living in about 2 700 informal settlements across South Africa. Approximately 8% of all informal households reside in South Africa's largest cities (SEA 2014). State support services reach few of these people, and even though informal settlement electrification is gaining ground in the country, they remain amongst the most marginalized population.
4. **Persistent high unemployment rates** of around 25% (or around 34% if discouraged work-seekers are included). To date the state has generally not been able to generate jobs at a rate equal to the increase in demand, despite the fact that promoting employment and reducing

poverty and inequality are priorities in almost every government policy document. Poverty, and the pressure on state welfare subsidies, therefore persist.

5. **A history of centralized energy planning** – historically such planning was undertaken *de facto* by Eskom – the national electricity utility - and the oil companies, and driven by the need for energy security in the face of apartheid sanctions. This has shifted and national government now has a stronger planning role, but the culture of centralized planning persists, and the **strong role of municipalities in directing the country's energy future remains inadequately recognised**. Despite this, energy planning capacity in a few South African cities has developed markedly in the past 5 years in particular, and such capacity is increasingly being institutionalized (SoE 2011).
6. **An abundance of low cost energy** in the country largely because of significant cheap coal availability and a historic electricity generation oversupply. This resulted **in inefficient use of energy**.
7. **Large-scale state sponsored low-income housing programmes** have delivered almost 3 million houses in the past decades. However because the success of the programme was measured by delivery numbers, the houses were generally poorly built structures with no ceilings, and were located on the urban margins where land is cheaply available. As a consequence these houses often have **poor thermal performance** and perpetuate the low density urban characteristic. **Poor residents therefore remain far from economic opportunities**, benefit little from urban amenities and have high transport costs.
8. **A national electrification drive to support poverty alleviation**, which has reached almost all urban formal houses, and is being extended to urban informal areas. The state funds this electrification, and provides a Free Basic Electricity consumption subsidy for low income electricity consumers, although the subsidy only reaches 69% of the indigent population (DoE 2013b). The state has also attempted to introduce a subsidy for non-electrical energy (such as LPG) but implementation of this Free Basic Alternative Energy scheme has proven problematic (Wolpe & Reddy 2010). In spite of all the state's efforts, poverty remains rife and inequality in the country is extreme.
9. **A recent electricity supply crisis** because of demand growth coupled with complacency of electricity planning decision-makers due to the long history of oversupply. The resulting blackouts have promoted more prudent use of electricity.
10. **Recent fast rising electricity prices** to fund the urgent new generation build programme, and **steady liquid fuel price increases** linked to international market prices. This has also promoted more efficient use of energy.
11. Due partly to the culture of centralized energy decision-making, **decentralised small-scale embedded generation is developing slower than optimal** – such as rooftop solar PV.
12. **Low adoption of energy alternatives such as renewable energy** because of historically low energy prices. This has started to shift because of higher local energy prices and steadily decreasing renewable energy prices internationally, and national government has recently launched a large scale renewable energy programme targeting several '000 MW of primarily wind and solar electricity generation.
13. **A high carbon footprint per capita** due largely to the reliance on coal, which makes up 67% of primary energy supply. South Africa is ranked 15th amongst the world's carbon emitters per capita. This is putting increasing pressure on the country to pursue stronger mitigation actions such as energy efficiency and renewable energy. While impressive policies and strategies exist – even at a municipal level in many cases - inertia is great, and the required fundamental changes to the energy sector and economy are slow.

Current urbanization situation

The total population in South Africa is growing at around 1% p.a., and the urbanisation rate in South Africa is 1.2% p.a. The population is predominantly urban, and currently 64% of the approximately 52 million total population live in towns or cities, of which 40% are located in the large metros. This is expected to increase to 70% by 2030 (StatSA 2011, IUDF 2013).

Cities and large towns produce 80% of South Africa's Gross Value Added (GVA[1]), and home to around two-thirds of the population, but have some of the lowest densities in the world (see Figure 1). South Africa is classified as an upper-middle income country but contains deep socio-economic inequalities (IUDF 2013). This is reflected in the rural-urban divide as well as within cities, as indicated by the significant informal housing sector (comprising 13% of the urban population) and lack of access by poor populations to city amenities. The apartheid urban form with all its disadvantages for the poor, as well as the negative implications for resource efficiency due to low overall densities, has changed little over the past decades.

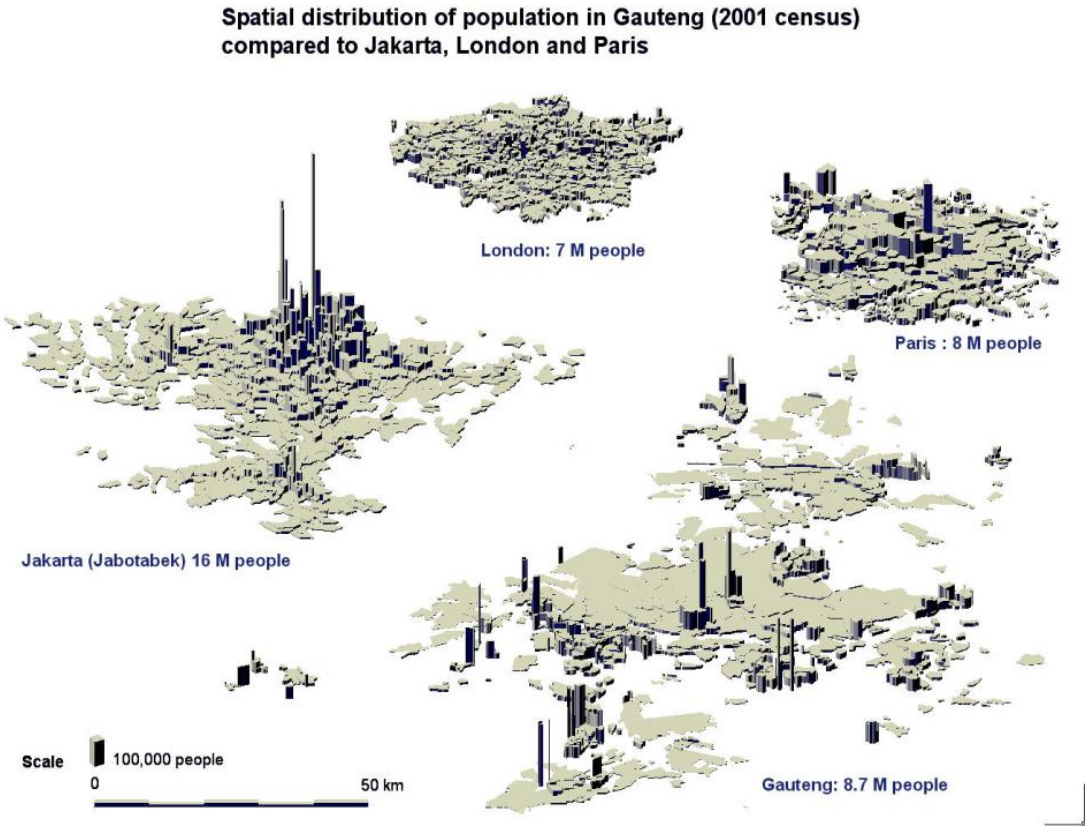

Figure 1: Densities of international cities, showing the relatively low density of Gauteng

There are a total of 286 municipalities in the country. From the point of view of identifying the most significant urbanization challenges in the country, it is useful to look at the urban settlements with both significant populations and high growth rates. National statistics indicate that amongst those that have around 100 000 population or above, growth rates in 26 of them are above 2% p.a., and 12 of them are growing at over 3% p.a. for the 2001-2011 period (see

[1] GVA – a measure of economic productivity

Appendix B). Only two are growing at over 4% p.a. for this period. To illustrate the implications of such growth rates, a 3.5% p.a. growth will lead to a doubling of population in 20 years. Given the lack of capacity in local government (see next section), unless major efforts are made to improve the situation it can be expected that such challenging urbanization rates will far exceed the municipality's ability to deal with the issue, with resulting stagnation or decline in welfare.

The urban institutional context

South Africa has three separate spheres of government – national, provincial and local or municipal government. Each has their own mandates which are largely derived from the Constitution. They are required to cooperate with each other, but are not functionally responsible for the mandates of the others, although national and provincial government is required to support local government in carrying out its role (COGTA 2013). Within national government, the Department of Cooperative Governance and Traditional Affairs (COGTA) provides this support function. The South African Local Government Association (SALGA) provides a coordinating function amongst local government, and represents local government to national government and elsewhere on issues of relevance to them. In spite of a clear separation of most mandates and functions, policies across the three spheres of government, or even in any one sphere, are often are poorly coordinated or conflicting.

155. Establishment of municipalities.—(1) There are the following categories of municipality:

(*a*) **Category A**: A municipality that has exclusive municipal executive and legislative authority in its area.

(*b*) **Category B**: A municipality that shares municipal executive and legislative authority in its area with a category C municipality within whose area it falls.

(*c*) **Category C**: A municipality that has municipal executive and legislative authority in an area that includes more than one municipality.

Insert: Types of municipalities as defined by the Constitution of South Africa (1996)

Municipalities are the seat of service delivery, and their mandate includes the following in terms of the Constitution (1996):

- air pollution
- building regulations
- electricity reticulation
- municipal planning
- municipal public transport
- stormwater management
- water and sanitation services
- refuse removal and solid waste disposal
- municipal roads
- streetlighting
- traffic and parking

The overarching planning framework in each local government is their Integrated Development Plan (IDP) which covers a 5 year period. This is supported by key planning documents such as

the Spatial Development Framework and the Medium-Term Income and Expenditure Framework. The Integrated Urban Development Framework discussion document (IUDF 2013) notes that local government planning is too short-term, and advocated an overarching 30 year planning framework. Local government is able to raise revenue from property rates and service delivery payments, amongst other sources. They are also the recipient of various conditional and unconditional grants from national government, including the Equitable Share Grant (which includes the Free Basic Electricity grant) and the Municipal Infrastructure Grant. Municipalities are also able to raise loans.

As noted in earlier sections, there is great concern regarding the capacity of local government to address their service delivery mandates, particularly in the face of rapid urbanization occurring in many towns and cities. In addition, municipal finances are often under stress, both because of capacity and management issues as well as revenue shortfalls (FCC 2013). This exacerbates service delivery backlogs and results in inadequate attention to the maintenance and upgrading of key infrastructure such as electricity distribution systems. In South Africa about 179 municipalities are licensed electricity distributors, although the national utility, Eskom, also distributes directly to small and large customers in many urban areas. The lack of attention to municipal electricity infrastructure is of great concern, as electricity sales are a critical source of revenue for many municipal distributors as it cross-subsidises other important municipal functions. A degradation in the electricity distribution system, while not necessarily urgent in any particular financial year, will have serious consequences for municipal finances in the medium-term.

The urban institutional context regarding energy is sometimes complicated and has various shortfalls. Amongst these are:

- Transport-related mandates are spread across different spheres of government. Urban rail is a national government function and most bus services are provincially controlled, making integrated transport planning difficult and inefficient. In addition different categories of roads are the responsibility of different spheres of government, even within an urban boundary. There is a move to create Transport Authorities in the large cities to assist in coordinated planning and implementation, but experience in eThekwini suggests that these authorities are not effective as they do not control the budgets – which still sit under the different government spheres.
- Low-income housing delivery is primarily a national government function
- Some municipal areas have electricity distribution rights divided between both municipal Electricity Departments and Eskom for historical reasons, causing some confusion, planning inefficiencies and tariff differences in areas within one municipal jurisdiction.

Implementation of sustainable energy-related interventions touches on all of these areas in some way, which provides a challenge to local governments wanting to pursue a sustainable energy future in a way that may not align with, or may be more progressive than existing national or provincial plans. These challenges are currently being grappled with as cities with Energy Strategies work at furthering these agendas. The recent process of developing an Integrated Urban Development Framework (IUDF 2013) for the country is also likely to promote more effective urban governance and may reduce such institutional inefficiencies.

Current urban energy challenges

Over the past two decades there has been much work done in the country to understand and work towards a sustainable urban future from an energy perspective. This work was largely undertaken as a part of State of Energy report or Energy Futures study research (e.g. SEA 2003, Ward 2008, Cape Town 2011) which preceded the development of City Energy Strategies, and is now reflected in these Strategies (e.g. Buffalo City 2008, Ekurhuleni 2006, Sol Plaatjie 2009, amongst others). The work is also increasingly reflected in national documents such as the Energy Efficiency Strategy (DoE 2008) and the Energy Efficiency Action Plan (DoE 2013), the National Climate Change Response White Paper (DEA 2011), the National Development Plan (NDP 2011), and the national electricity plan (IRP 2010) as the critical role of urban areas in the sustainable energy future of the country becomes increasingly apparent. The process by which the profile of the urban sustainable energy agenda was defined and highlighted is documented in various papers by Sustainable Energy Africa (SEA 2008, Wolpe et al 2012). This has included the need for data strengthening[2]. Because of the depth of the abovementioned research undertaken over the past decade or more, and because of years of implementation efforts around these issues, the key elements to a sustainable urban energy future have now effectively become common knowledge. They include the following:

- Improving **electrical energy efficiency** in the building sector (commercial and residential), which involves:
    - ensuring that new buildings are energy efficient
    - retrofit programmes to address existing stock (e.g. solar water heaters and LED lighting)
- Improving **transport** efficiency and travel avoidance, which includes:
    - densification or corridor densification of urban areas
    - provision of public transport
    - more efficient modes of transport (e.g. elec vehicles)
    - demand-side measures such as private vehicle occupancy increases
    - mixed use zoning to reduce travel needs
- Greater share of **renewable electricity generation** in the mix, including:
    - smaller decentralized electricity generation options such as rooftop solar PV and landfill gas generation
- Improving the **welfare of the poor** and reducing their energy burden through:
    - thermally efficient housing
    - use of efficient technologies such as solar water heaters

[2] Data strengthening is illustrated by reports such as the State of Energy in South African Cities (SEA 2006 and 2011). See Appendix C for a data overview.

- reducing the travel cost burden through better located land, improved public transport and mixed-use zoning to reduce travel needs
- Ensuring universal access to electricity
- Managing affordability of electricity for the poor to reduce the poor turning to of less safe and efficient energy sources

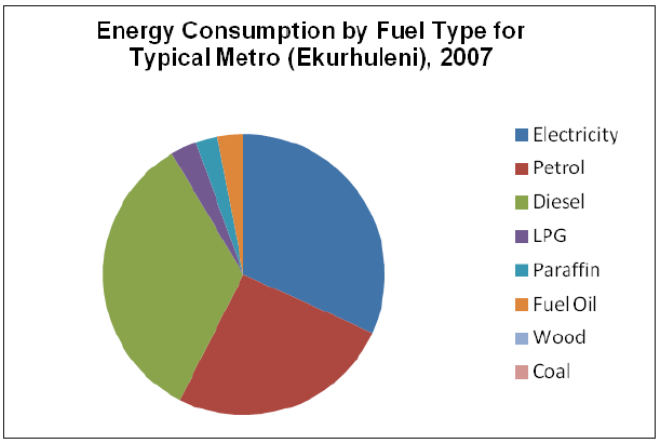

Figure 2: Energy consumption of a typical city (SEA

Although focus areas such as improving industrial process efficiency, implementing large-scale renewable electricity generation programmes, and introducing biofuels are important for sustainability, these largely sit outside the mandate and influence of local government and therefore have not been central to municipal energy efforts, and will not be covered in this document.

The above areas of focus make it clear that urban planning and energy sustainability are closely related, and require an adequate policy and regulatory framework, and importantly, national and local capacity within government to implement them. As the National Development Plan points out, while South Arica has well considered policies and strategies in general, the capacity of government to take these forward is uneven, and often highly inadequate (NDP 2011). Detailed assessments of local government capacity confirm this (PDG 2012).

Sustainable urban energy interventions

This document will now focus on specific areas of intervention based on the above to clarify challenges and opportunities, look at what is being done around these and to what effect.

Transport, urban form and energy

Transport typically is responsible for around half of total energy use in urban areas, and a third of global warming emissions (SEA 2011). It is thus a key focus area for urban energy transitions. The larger municipalities all produce Integrated Transport Plans (ITPs) as well as Spatial Development Frameworks (SDFs). Interestingly, while these documents are very interdependent, communication and coordination between the responsible departments is often seriously lacking (DoT 2010, SACN 2013). This is a problematic situation. Sustainable transport efforts need to be supported by urban densification, potentially along corridors, and the firm holding of appropriate zoning schemes and an urban edge. Analyses in South Africa and internationally are clear on the financial and other benefits of a denser, appropriately zoned city, and this imperative is now generally accepted (see IUDF 2013, SEA 2011a, SEA 2013, DoT 2010).

Urban sustainable transport initiatives include interventions such as[3]:

[3] See Kane (2011) for a more comprehensive list.

- Public transport improvement (e.g. Bus Rapid Transit, rail)
- Improved walkability of destinations to encourage public transport
- Non-motorised transport facilities and lanes
- Inter-modal public transport coordination and integrated ticketing
- Disincentives for private vehicle use
- Incentives to increase private vehicle occupancy (e.g special parking facilities)
- School bus promotion (school lift traffic is significant in many areas)

Examples of efforts and achievements of some cities are given below:

> In the City of Joburg sustainable spatial development is being promoted by mandatory criteria for new developments that lead to improved access to public transport and concentration of development in priority zones and corridors (e.g. see CoJ 2008).
>
> The cities of Joburg, eThekwini and Cape Town have Bus Rapid Transit schemes in place, and a number of other urban areas are planning such interventions as they are regarded as a success[4].
>
> Cape Town has a progressive SDF and supportive Densification and Urban Edge policies. However, not only is coordination with transport planning weak, but political decisions have blatantly frustrated the intentions of these documents several times in the past years.
>
> 'Park and Ride' facilities have been introduced by several urban areas around key public transport hubs.
>
> Gauteng province has a high-speed train (the 'Gautrain') linking the three metros of Joburg, Ekurhuleni and Tshwane.

Sustainable transport motivations are two-tracked. One emphasizes efficiency in transport systems with associated reduced costs and greenhouse gas emissions, the other seeks to improve the mobility of the poor (see Figure 3 for modes used by different income groups). The former often focuses on getting people out of private vehicles and onto public transport. The latter is particularly important given that poor settlements generally occupy land far from employment opportunities and urban amenities (Maphakela et al 2013). The minibus taxi industry in South Africa arose out of the lack of decent public transport for the poor, experienced huge growth from the mid-1980s to the mid-1990s, and is now a permanent part of the transport picture and formally integrated into transport planning in all urban areas. It is the most important form of public transport in the country, and carries 65% of urban passengers to their destinations (Polity 2013). Government has instituted regulations to promote safety and has incentivized vehicle efficiency in this industry, although much is still to be achieved in this area (DoT 2010).

It is informative to note that this minibus taxi mode of transport, which is recognized as addressing commuter needs relatively well in terms of routes, prices and speed, arose out of

[4] Although it is too early for comprehensive evaluations to have emerged (e.g. Grey and Behrens 2013).

entrepreneurs responding to an obvious lack in their communities rather than through formalized planning and infrastructure investment.

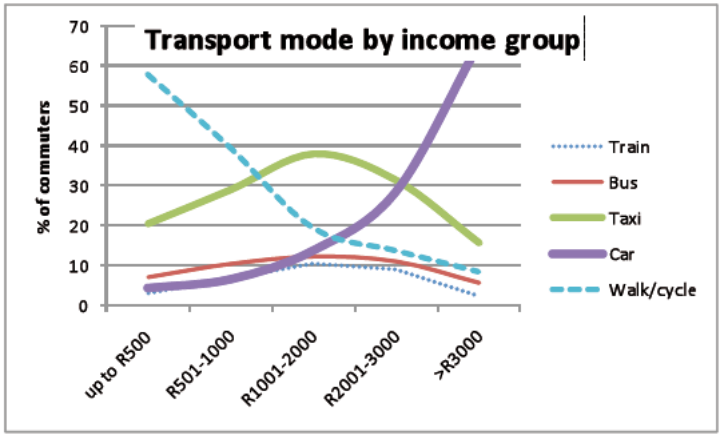

Figure 3: Showing dependence of the poor on non-motorised or public transport, and the use of private vehicles by the wealthy (DoT 2003)

Changing the transport and spatial profile of urban areas is a slow and often expensive undertaking, and achieving modal shifts to public transport is not straightforward (Venter et al 2013, SACN 2013). While urban areas have shifted significantly in approach over the past decade (SEA 2011), the overall impact on the energy and sustainability situation is limited and it remains far from efficient and sustainable (SACN 2013). Far greater political commitment to such transformation together with continued shifts in 'business as usual' approaches by officials, and significant financial support from national government to fund expensive public transport infrastructure are all necessary to accelerate the pace of transformation.

Electricity efficiency

The recent power crisis of 2008, steep increases in electricity prices as well as carbon mitigation pressures (to a lesser extent) have led to electricity efficiency being given more attention. Historically electricity prices were very low in the country, and thus efficiency has been a low priority. However it has long been clear that saving electricity is far cheaper than generating it (SEA 2008a). For the past few years Eskom has been running a significant electricity efficiency subsidy programme funded by tariff revenue (IDM 2013). It has achieved savings costing under ZAR5 million per MW, compared with conventional generation cost of over ZAR10 million per MW (SEA 2008a). As a part of this programme Eskom rolled out a massive programme to replace inefficient incandescent lights with CFLs or LEDs in residential and commercial facilities. Because of this programme, efficient technologies are now becoming the norm. In addition, the Department of Energy has allocated significant money to selected municipalities for the implementation of electricity efficiency[5] and those granted the funds have successfully undertaken substantial streetlight and traffic light retrofits (sometimes with LED technology), as well as public building lighting retrofits. Experience with this programme indicates that municipalities require support to be able to engage with such programmes effectively – it is not enough to merely allocate funds to them. However, with support in the initial phases, municipalitites can run these programmes sustainably thereafter (Euston-Brown 2013).

[5] As part of the DORA (Division of Revenue Act) grant (SEA 2012)

Over the past three years National Treasury has also approved a range of rebate incentives for private electricity efficiency interventions.

A national solar water heater programme has been rolled out by the Department of Energy and Eskom (Eskom 2013), as the financial, economic and environmental benefits of this technology have long been known. The programme comprises a low-income household and high-income household component. The former is fully subsidized and uses low pressure technology, while the latter is only partly subsidized (around 20% of capital cost). Solar water heater penetration still remains far from widespread however, and the future of the subsidy schemes uncertain. Cape Town leads the country in mass solar water heater rollout, and has recently launched an accreditation scheme for suppliers to accelerate implementation (Cape Town 2013).

Although the use of ESCOs has been very slow in taking off in South Africa[6], a few municipalities have recently contracted ESCOs around building efficiency programmes. However the municipal legal frameworks make standard ESCO contracting relatively complicated. Several cities have run electricity efficiency awareness campaigns for residential and commercial sectors (the industrial sector is generally covered by the Eskom IDM programme).

Low-income housing constructed as part of the mass state housing drive of the past 20 years generally has very poor thermal performance. Most houses do not have ceilings, leading to excessive heat and cold in different seasons, and pushing up energy expenditure as residents try to keep warm in winter. It also exacerbates indoor air pollution and associated respiratory illnesses because residents often use coal, wood or paraffin for heating. While there are several efficient and sustainable pilot housing projects around the country, until recently this had little impact on the mass rollout programme, partly because of financial constraints. In 2013 national government announced the introduction of several efficiency interventions as mandatory for low income housing, including ceilings, insulation and other thermal design improvements, and allocated budget to cover the additional costs. This is a significant and very positive development for the country. Currently the National Department of Human Settlements is monitoring a sustainable, high-density housing programme in Joe Slovo settlement in Cape Town in order to assess the feasibility of further housing delivery policy changes along these lines (Janisch 2013).

Renewable energy

Renewable energy, and in particular renewable electricity generation, has generally not been a focus of local government in South Africa, partly because electricity planning has been centrally held with no specific allocation for local government included in national implementation plans[7]. With recent international renewable energy price decreases, local electricity price rises, and climate change pressures, as well as the confidence instilled by the major national renewable electricity programme (one of the biggest in the world currently), this situation is starting to shift. eThekwini municipality has implemented a landfill gas generation project (around 6MW), and other cities are planning to follow suite. A few cities are looking at run-of-pipe[8] hydro schemes, which may deliver up to 5MW of power each.

[6] For an overview of ESCOs in South Africa see Volschenk (2007).
[7] Notably the 2010 Integrated Resource Plan produced by the Department of Energy (IRP 2010).
[8] Hydro turbines installed in the large pipes of the municipal water distribution system

One of the most promising and fastest growing renewable electricity options is rooftop solar PV embedded generation, and most cities are scrambling to develop technical and business frameworks to accommodate the applications from private households and businesses wanting to install such systems. A number of private rooftop PV projects of over 0.5MW are already in existence in the country. Initial assessments indicate that this could grow to hundreds of megawatts around the country in the short-term. However it is acknowledged that the resulting impact on the municipal electricity load profile will need to be monitored as implementation accelerates (Ramaya 2013).

It is however mostly cities that are engaging in the area of renewable generation, as they tend to have some capacity to respond to these pressures and opportunities. Smaller towns are hard pushed to engage in these areas due to more severe capacity constraints.

The barrier of municipal revenue losses

Historically, one of the barriers to implementing energy efficiency and some renewable energy options has been the reduced municipal electricity sales that would result, and the corresponding reduction in revenue generated by municipal electricity distributors. Because electricity revenue is such a key source of revenue for many municipalities, and there is increasing pressure on these finances for infrastructure upgrades and service delivery, these threats resulted in little headway being made for many years. However, today pressures are such that municipalities are obliged to proceed with sustainable energy interventions in spite of such concerns. A study undertaken in 2012 (and currently being refined), showed the extent of revenue loss that could be expected. While they are significant (typically between 2 and 5% of revenue within 10 years) , municipalities are at least now able to put plans in place to ensure that their revenue is protected while still promoting such sustainable energy interventions (SEA 1012a).

Poverty and access to energy

As noted earlier in various sections, South Africa has not been able to address poverty levels substantially. The main energy dimensions of this include thermally uncomfortable housing (discussed earlier) and lack of access to modern, affordable energy sources. On average poor households spend 14% of their income on basic energy needs, as opposed to 2 or 3% for wealthier households (Swart and Bredenkamp 2012, DoE 2013b, SEA 2014). In South Africa the 'modern energy' focus has been on electricity provision, which also appears to be the most sought-after energy source with the greatest welfare benefits (Wolpe et al 2012).

The National Electrification Programme has achieved impressive electrification levels throughout the country. National electrification levels are at 87 % (DoE 2012) compared to 36% in 1994. However, significant numbers of households remain without an electricity connection: the current electrification backlog is 1.2 million informal and 2.1 million formal households (DoE 2012). Some municipalities have approached the issue proactively and have electrified informal settlements by using

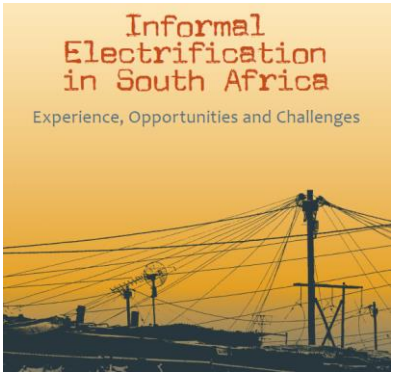

Figure 4: Experience with informal settlement electrification is increasing (SEA 2012b)

appropriate technologies[9]. However many municipalities have not made a significant impact in this sector, although experience with appropriate approaches is growing and implementation is steadily increasing (Figure 4).

The Department of Energy attempted to implement a Free Basic Alternative Energy (FBAE) scheme so that unelectrified informal dwellers could benefit from state subsidies in the same way that poor electrified households do through the Free Basic Electricity grant, but the scheme was not effective. Observers hold out little hope that it will form a useful part of future sustainable energy efforts unless substantially reconceptualised (Wolpe and Reddy 2013). However energy supply networks do exist in informal areas, through small and micro traders selling paraffin, for example. These have been reliable and functional for decades. Government may be able to learn from, or link to such distribution networks if FBAE is to be continued into the future.

Low carbon imperatives

Because South Africa is a significant per capita carbon emitter by international standards (Figure 5), several cities around the country pioneered the establishment of Energy and Climate Change Strategies, often with ambitious targets around carbon reductions (Figure 6). The earliest date back to 2003 (SEA 2008). This was well ahead of national government's progression, which eventually released the National Climate Change Response White Paper eight years later in 2011, in time for COP17 being held in eThekwini.

Figure 5: Carbon footprint of South African cities compared with international examples

Cities recognized that development agendas were the highest political priority in the country, not carbon emissions, and thus these strategies emphasized the resource and cost savings, security and disaster management advantages, and economic opportunities in embracing low carbon development, and they embedded strong welfare support initiatives in many activity areas.

[9] Municipalities will not electrify informal settlements on private land – they consider that installing state assets on private land is not permissible, and such projects will also not receive state subsidies,

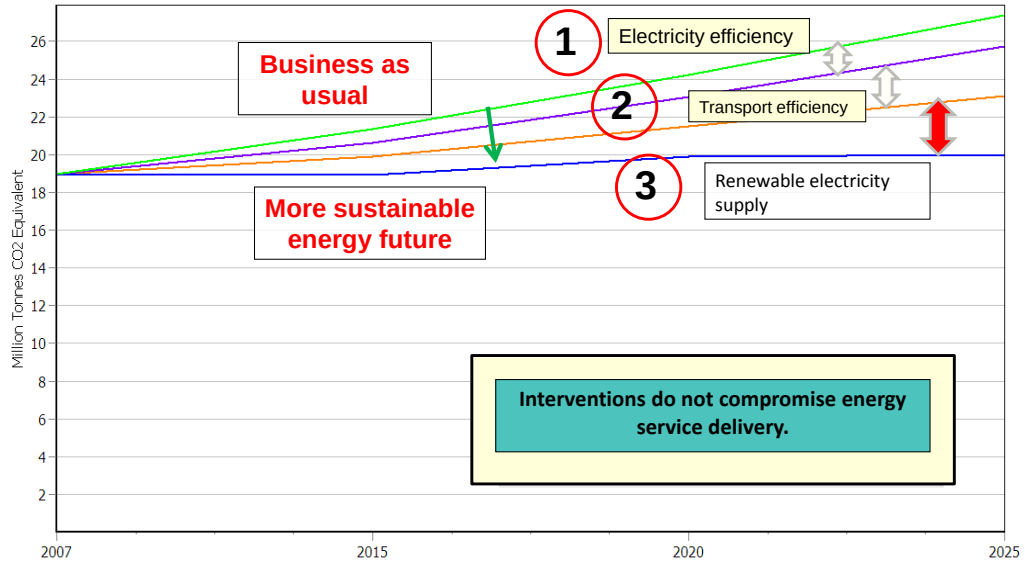

Figure 6: An example of city carbon futures modeling showing the impact of different sets of interventions on carbon emissions (Cape Town 2011)

In spite of such proactivity, it has taken time for cities to transform institutionally such that they are effectively implementing these strategies. Within cities, the electricity efficiency programmes have arguably been the most effective, and renewable energy options are now showing promise – such as the rooftop solar PV systems. Sustainable, efficient building in the public and commercial sector is also steadily gaining ground[10]. Transport profile changes are slow however, partly because of the large infrastructure investments required to make significant changes to the modal use patterns, and partly because of the interdependence and poor coordination with urban spatial form. In any case, even in the most proactive of scenarios urban form changes very slowly.

Support for implementation

Towns and cities lack the resources, institutional frameworks and capacity to engage in the emerging area of sustainable energy implementation, yet are under pressure to make headway – often in terms of the targets set in their Energy and Climate Change Strategies and Action Plans. Although there are several funding programmes available for sustainable energy in urban areas, the capacity in these areas to utilize the funds is often inadequate or non-existent. Sustainable Energy Africa has been running a City Energy Support Unit for the past decade to meet this need, and has developed and collected an array of resource documents, guides and support tools for municipalities embarking on a more sustainable energy trajectory (see Figure 4 and www.cityenergy.gov.za). In addition to these resources, Sustainable Energy Africa runs a learning network of cities and towns in order to facilitate mutual learning and build capacity of urban officials involved in this area. The particular partnership methodology for providing support has evolved over the years and has proven effective in facilitating implementation (SEA 2008).

[10] Linked to efforts by the Green Building Council of South Africa (www.gbcsa.org.za)

The South African Local Government Association (SALGA) and the South African Cities Network (SACN) have also become involved in supporting urban areas with sustainable energy and climate change planning in recent years.

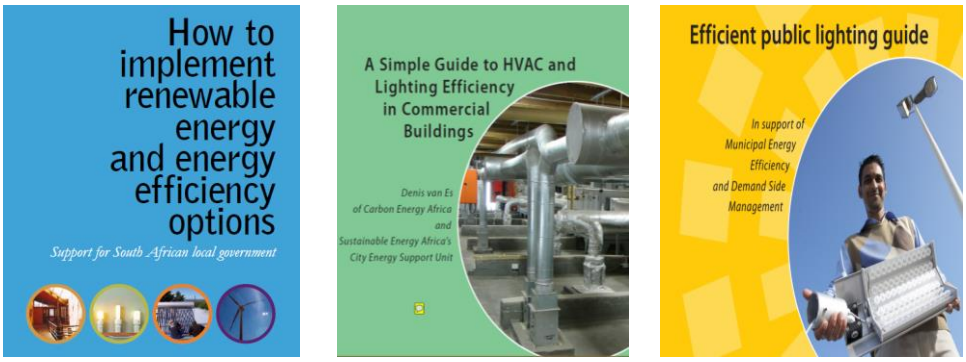

Figure 4: Some guides on electricity efficiency and renewable energy from www.cityenergy.gov.za

Some implications and lessons for the SAMSET project

Based on the above overview of the South African situation regarding sustainable urban energy transitions, the following implications for the SAMSET project arise:

1. Generally, there is much activity in the country around sustainable urban energy transitions. There are also a number of support initiatives and organisations in addition to Sustainable Energy Africa, such as the South Africa Cities Network, the South African Local Government Association (SALGA), and GIZ (working through SALGA). Coordination with and building on existing initiatives is thus important to maximize the benefit for the country.
2. Although all municipalities in South Africa are capacity constrained, relatively speaking bigger cities are better resourced and more proactive regarding sustainable energy. Smaller cities and towns are usually more severely capacity constrained and so moving into new ways of operating or implanting different projects is more of a challenge.
3. In South Africa, when one municipality has pioneered approaches in a particular area, others feel much more confident in moving forward in that field. Bureaucrats are conservative by nature. Taking the lessons of the pioneering cities to the smaller cities and towns may present a worthwhile focus.
4. Transport and urban form change very slowly. The two are closely interrelated, yet sit in separate municipal departments which do not work together effectively in most cases. Given that shifts in urban form are a critical component of sustainable transport implementation, cooperation facilitation between these departments in an important future focus area. This may be most critical in smaller, fast growing towns, where capacity to engage with these issues is limited yet consequences of poor planning are serious and manifest quickly.
5. The capacity constraints of municipalities is unlikely to shift significantly in the medium-term. Ongoing support will be necessary and will be well used. Yet the SAMSET project needs to see that in 4 years when it is complete, the areas where it has been active are able to continue developing. Experience shows that in some areas, support is needed only to establish new ways of operating, and once this is in place there is limited need for extra capacity for them to continue on the new trajectory. SAMSET will need to keep this in mind.

6. There has been a substantial focus on electricity efficiency in larger cities rather than smaller urban areas in order to maximize impact. While the efficiency opportunities in these cities are far from saturated, smaller cities and towns also have significant opportunities which remain unexploited. Support here may be useful.
7. Informal electrification appears to be accelerating at a reasonable rate in the country, and there may be little need for support here. But it is worth 'watching this space', because how different municipalities will engage with this challenge remains uncertain.
8. Decentralised renewable electricity generation in municipalities is receiving support at present, although this focuses mainly on the cities. Support for smaller cities and towns may be appropriate.
9. Because national government policies do not always support local sustainable energy and urbanization agendas, SAMSET will need to consider feeding emerging local needs into national government processes.

REFERENCES

Brent A, undated. *Overview: Renewable and sustainable energy needs for the Southern African industry*. Centre for Renewable and Sustainable Energy Studies, Stellenbosch University, South Africa.

Buffalo City 2008. *Buffalo City Energy Strategy*. Buffalo City, South Africa.

Cape Town 2011. *Cape Town State of Energy and Energy Futures Report*. City of Cape Town.

Cape Town 2013. *Cape Town steps up drive to roll out Solar Water Heaters*. Press Release 4 November 2013. www.capetown.gov.za

COGTA 2013. Dept of Cooperative Governance and Traditional Affairs website www.cogta.gov.za

CoJ 2008. *Design Guidelines for Energy Efficient Buildings in Johannesburg*. City of Johannesburg.

Constitution 1996. *The Constitution of South Africa*. Government of South Africa.

DEA 2011. *National Climate Change Response White Paper*. Department of Environmental Affairs. Pretoria.

DoE 2002. *White Paper on the Promotion of Renewable Energy and Clean Energy Development*. Draft. Department of Energy, Pretoria

DoE 2008. *Energy Efficiency Strategy of South Africa*. First Review 2008. Department of Energy, Pretoria.

DoE 2012. *A survey of energy-related behaviour and perceptions in South Africa: The Residential Sector*. Department of Energy, Pretoria.

DoE 2013. *National Energy Efficiency Action Plan*. Draft for comment. Department of Energy, Pretoria.

DoE 2013b. Presentation on the Integrated National Electrification Programme made to the Parliamentary Portfolio Committee on Energy on 10th September 2013. South Africa.

DoT 2003. *National Household Travel Survey, 2003.* National Department of Transport, Pretoria.

DoT 2010. *National Transport Masterplan*. Department of Transport, Pretoria.

Ekurhuleni 2006. *Ekurhuleni Metropolitan Municipality Energy and Climate Change Strategy*. Ekurhuleni Metropolitan Municipality, South Africa.

Eskom 2013. *The Solar Water Heating Programme*. Eskom website http://www.eskom.co.za/AboutElectricity/FactsFigures/Documents/The_Solar_Water_Heating_SWH_Programme.pdf

eThekwini 2008. *eThekwini Municipal Energy Strategy*. eThekwini, South Africa.

Euston-Brown M 2013. Pers Comm, Megan Euston-Brown, Project Manager. November 2013. Sustainable Energy Africa, Cape Town.

FFC 2013. *Sustaining Local Government Finances: Review of the Local Government Fiscal Framework*. Financial and Fiscal Commission, Pretoria.

Gauteng 2009. *Gauteng Integrated Energy Strategy*. Gauteng Provincial Government, South Africa.

Grey and Behrens 2013. *A case for smarter city growth : a strategic analysis of Cape Town's Phase 1A BRT system and its supporting land use environment*. Grey P, Behrens R. 32nd South African Transport Conference.

IDM 2013. Eskom Integrated Demand Management Programme website http://www.eskom.co.za/sites/idm/Pages/Performance%20Contracting.aspx

IRP 2010. *Integrated Resource Plan 2010*. National integrated electricity planning document. Department of Energy, Pretoria.

IUDP 2013. *Towards an Integrated Urban Development Plan*. Department of Cooperative Governance and Traditional Affairs, South Africa.

Janisch A 2013. *Joe Slovo Lessons Learned Report*. For Department of Human Settlements. Sustainable Energy Africa, Cape Town.

Kane L 2011. *Strategies for Reducing Energy Use (and Carbon Emissions) in the Cape Town Transport Sector*. Sustainable Energy Africa, Cape Town.

Maphakela et al 2013. *Building a sustainable platform for low-cost mobility in South Africa.* Maphakela W, Mashiri M, Chakwizira J, Mpondo B. 32nd South African Transport Conference.

NDP 2011. *National Development Plan* of the National Planning Commission of South Africa. Government of South Africa.

PDG 2012. *Final National Report on Trends in Municipal Capacity for the 2010/11 Municipal Financial Year*. By Palmer Development Group for the Municipal Demarcations Board, Govt of South Africa, Pretoria.

Polity 2013. *The minibus taxi industry in South Africa: A servant for the urban poor?* www.Polity.co.za .

Ramaya J 2013. Initial unpublished assessments as a part of the BHC-funded *Solar PV Embedded Generation Support Project* of Sustainable Energy Africa, Cape Town.

SACN 2013. *Literature review on public transport and mobility in municipalities*. For South African Cities Network. By Geoffrey Bickford, ARUP, Johannesburg.

SEA 2003. *Energising South African Cities and Towns*. Sustainable Energy Africa, Cape Town.

SEA 2006. *State of Energy in South African Cities 2006*. Sustainable Energy Africa, Cape Town.

SEA 2008. *Energy Planning in South African Cities*. In Urban Energy Transitions, 2008. Droege P (ed). Elsevier, Newcastle, Australia.

SEA 2008a. *The elusive 'nega-watt' - Why and how electrical energy efficiency needs to be scaled up in the next few years of power supply shortage in South Africa*. A summary of a synthesis study. November 2008. Sustainable Energy Africa, Cape Town. November 2008.

SEA 2009. *How to implement renewable energy and energy efficiency options: Support for South African local government*. Sustainable Energy Africa, Cape Town.

SEA 2011. *State of Energy in South African Cities 2011*. Sustainable Energy Africa, Cape Town.
SEA 2011a. *Energy Scenarios for Cape Town.* Sustainable Energy Africa, Cape Town.
SEA 2012. *DORA funded DOE Municipal EEDSM Programme: Capacity Building and Job Creation case studies*. Sustainable Energy Africa City Energy Support website: www.cityenergy.org.za
SEA 2012a. *The potential impact of efficiency measures and distributed generation on municipal electricity revenue: double whammies and death spirals*. Presented at the 2012 AMEU Conference. By Sustainable Energy Africa, Cape Town.
SEA 2012b. *Informal Electrification in South Africa: Experience, Opportunities and Challenges.* Sustainable Energy Africa, Cape Town.
SEA 2013. *Energy scenarios for eThekwini: Exploring the implications of different energy futures for eThekwini Municipality up to 2030*. For eThekwini Energy Office. Sustainable Energy Africa, Cape Town.
SEA 2014*. Tackling Urban Energy Poverty in South Africa*. Sustainable Energy Africa, for Heinrich Böll Stiftung Cape Town.
SI 2009. *Sustainable Neighborhood Design Manual*. Sustainability Institute. Stellenbosch, South Africa.
SoE 2011. *State of Energy in South African Cities 2011*. Sustainable Energy Africa, Cape Town.
Sol Plaatjie 2009. *Sol Plaatjie Energy and Climate Change Strategy*. Sol Plaatjie Municipality, South Africa.
StatsSA 2011. Statistics South Africa data from the 2011 census. www.statsa.gov.za. Pretoria.
Swart D and Bredenkamp B 2012. *The Challenge of addressing household energy poverty*. Presented at 'Towards Carnegie III' conference, September 2012, University of Cape Town.
Tshwane 2006. *City of Tshwane Energy Strategy*. Tshwane, South Africa.
Venter et al 2013. *Analysis of modal shift in South Africa : a qualitative investigation*. Venter K, Mokonyana M, Letebele M, Dube S, Masondo N. 32nd South African Transport Conference.
Volschenk J 2007. *The use of the ESCOs to facilitate sustainable energy interventions in the low income housing sector*. http://toolkits.reeep.org/file_upload/10307023_2.pdf Jako Volschenk, January 2007
Ward S 2008. *New Energy Book for Urban Development in South Africa*. Sustainable Energy Africa, Cape Town.
Western Cape 2007. *Sustainable Energy Strategy for the Western Cape*. Dept of Environmental Affairs and Development Planning, Western Cape Government, Cape Town.
Western Cape 2008. *Western Cape Climate Change Strategy and Action Plan.* Western Cape Government, South Africa.
Western Cape (2008). *White Paper on Sustainable Energy for the Western Cape Province*. Department of Environmental Affairs and Development Planning, Western Cape Government, Cape Town.
Wolpe P and Reddy Y 2010. *Alleviating urban energy poverty the informal sector: The role for local government*. Sustainable Energy Africa - Conference paper presented at 'Inequality and structural poverty in South Africa: Towards inclusive growth and development', Johannesburg, 20 September 2010
Wolpe P, Reddy Y and Euston-Brown M 2012. *Energising Urban South Africa: poverty, sustainability and future*. Presented at 'Towards Carnegie III' conference, September 2012, University of Cape Town.

Visagie E 2008. *The supply of clean energy services to the urban and peri-urban poor in South Africa*. In 'Energy for Sustainable Development' Volume XII No. 4 December 2008.

APPENDICES

APPENDIX A

General statistics on urban South African (StatSA 2011 unless otherwise stated)

Population	**51.8 million**
Population growth (annual rate)	1.18%%
Urban population	62%
Rate of Urbanisation (2010-2020 est.)	1.2%
Major urban areas – population (Census 2011)	Johannesburg – 4,488,843 Cape Town – 3,736,579 Ekurhuleni (East Rand) – 3,197,299 Ethekwini (Durban) – 3,481,147 Pretoria (Tshwane) - 2,961,022 Nelson Mandela Bay - 1,179,505
Urban residents living in slums	13%
GDP per capita (2012)	US$7,507
GDP – real growth rate	2.5%
GDP – composition by sector of origin	Agriculture – 2.6% Industry - 29.3% Services - 68.1% (2012 est.)
Average household income (Census 2011)	R103 204
Distribution of family income (Gini Index)	63.14 (2009)
Unemployment	25.6%
Electrification	84.7%
CO_2 emissions/ca (2009)	10.12 tCO_2e

APPENDIX B

Fastest growing municipalities in South Africa with ~100 000 people or above (StatsSA 2011)

Province	District	Munic/Metro	Pop. 1996	Pop. 2001	Pop. 2011	Growth 1996-2001	Growth 2001-11	Growth 1996-2011
Mpumalanga	Nkangala	Steve Tshwete	135,335	142,772	229,831	1.1%	4.9%	3.6%
Western Cape	West Coast	Swartland	65,301	72,115	113,762	2.0%	4.7%	3.8%
Mpumalanga	Nkangala	Emalahleni	236,040	276,413	395,466	3.2%	3.6%	3.5%
North West	Bojanala	Rustenburg	311,787	387,096	549,575	4.4%	3.6%	3.9%
Western Cape	West Coast	Saldanha Bay	56,557	70,261	99,193	4.4%	3.5%	3.8%
Gauteng	Sedibeng	Lesedi	66,206	71,868	99,520	1.7%	3.3%	2.8%
Eastern Cape	Cacadu	Kouga	63,241	71,390	98,558	2.5%	3.3%	3.0%
KwaZulu-Natal	iLembe	KwaDukuza	143,758	167,805	231,187	3.1%	3.3%	3.2%
Gauteng	**METRO**	**City of Johannesburg**	**2,638,471**	**3,226,055**	**4,434,827**	**4.1%**	**3.2%**	**3.5%**
North West	Bojanala	Madibeng	319,974	347,578	477,381	1.7%	3.2%	2.7%
Gauteng	**METRO**	**City of Tshwane**	**1,792,357**	**2,142,322**	**2,921,488**	**3.6%**	**3.2%**	**3.3%**
Limpopo	Waterberg	Lephalale	78,715	85,272	115,767	1.6%	3.1%	2.6%
Mpumalanga	Gert Sibande	Govan Mbeki	209,626	221,747	294,538	1.1%	2.9%	2.3%
Western Cape	Cape Winelands	Stellenbosch	103,996	118,709	155,733	2.7%	2.8%	2.7%
Western Cape	Cape Winelands	Witzenberg	76,386	89,087	115,946	3.1%	2.7%	2.8%
Western Cape	Eden	George	120,148	149,436	193,672	4.5%	2.6%	3.2%
Western Cape	**METRO**	**City of Cape Town**	**2,562,277**	**2,892,243**	**3,740,026**	**2.5%**	**2.6%**	**2.6%**
Western Cape	Cape Winelands	Drakenstein	186,334	194,417	251,262	0.9%	2.6%	2.0%
Free State	Fezile Dabi	Metsimaholo	106,912	115,955	149,108	1.6%	2.5%	2.2%
Gauteng	**METRO**	**Ekurhuleni**	**2,026,978**	**2,481,762**	**3,178,470**	**4.1%**	**2.5%**	**3.0%**
North West	Dr Kenneth Kaunda	Tlokwe City Council	124,813	128,353	162,762	0.6%	2.4%	1.8%
Limpopo	Greater Sekhukhune	Greater Tubatse	229,583	269,608	335,676	3.3%	2.2%	2.6%
Limpopo	Capricorn	Polokwane	424,835	508,277	628,999	3.7%	2.2%	2.7%
Mpumalanga	Ehlanzeni	Mbombela	426,090	476,903	588,794	2.3%	2.1%	2.2%
Gauteng	West Rand	Mogale City	226,446	295,505	362,422	5.5%	2.1%	3.2%
Northern Cape	Frances Baard	Sol Plaatjie	205,103	202,246	248,041	-0.3%	2.1%	1.3%

APPENDIX C

Energy consumption and GVA of South African cities (SEA 2011)

	Population		GVA		Energy Consumption			Electricity consumption	
2007	People	% of SA	2007 ZAR (millions)	% of SA	GJ	% of SA	Energy intensity (kJ/ZAR)	kWh/annum	% of SA
Cape Town	3,497,097	7.21	R 187,631	11.00	127,645,128	4.72	680.30	13,504,156,356	6.94
Johannesburg	3,888,182	8.02	R 238,803	14.00	142,612,254	5.27	597.20	14,593,279,736	7.50
Tshwane	2,345,909	4.84	R 153,516	9.00	104,513,830	3.86	680.80	11,814,438,718	6.08
Ekurhuleni	2,724,227	5.62	R 153,516	9.00	109,679,907	4.05	714.45	15,513,210,926	7.98
eThekwini	3,468,087	7.15	R 153,516	9.00	123,705,214	4.57	805.81	10,933,396,114	5.62
Nelson Mandela Bay	1,050,934	2.17	R 51,172	3.00	32,191,176	1.19	629.08	3,095,153,310	1.59
Metro total/Ave	16,974,436	35.00	R 938,154	55.00	640,347,509	23.67	684.61	69,453,635,160	35.72
Saldanha	78,985	0.16	R 4,359	0.26	23,477,790	0.87	5386.47	1,117,994,514	0.57
Sedibeng	800,833	1.65	R 22,845	1.34	88,944,560	3.29	3893.31	11,268,110,616	5.79
Industrial total/ave	879,818	1.81	R 27,204	1.59	112,422,350	4.16	4639.89	12,386,105,130	6.37
Buffalo City	724,308	1.49	R 34,115	2.00	21,430,786	0.79	628.20	1,293,287,136	0.67
Mbombela	527,203	1.09	R 11,544	0.68	11,684,300	0.43	1012.11	334,972,208	0.17
Msunduzi	616,733	1.27	R 17,057	1.00	25,034,993	0.93	1467.70	1,792,294,078	0.92
Polokwane	561,770	1.16	R 18,949	1.11	9,619,878	0.36	507.67	512,096,850	0.26
Sol Plaatje	243,015	0.50	R 7,210	0.42	5,642,450	0.21	782.57	371,974,286	0.19
Non-industrial total/ ave	2,673,029	5.51	R 88,876	5.21	73,412,407	2.71	879.65	4,304,624,558	2.21
Total	20,527,283	42.32	R 1,054,234	61.81	826,182,266	30.54		86,144,364,848	44.30
NATIONAL	48,502,063	100	R 1,705,735	100.00	2,705,336,000	100	1586.02	194,456,000,000	100.00

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