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EXPLORING THE CHALLENGES AND NICHE INNOVATIONS OF ENERGY SERVICE DELIVERY IN URBAN SOUTH AFRICA

AN OVERVIEW OF SEVEN CITIES















A research report from the ESRC-NRF URBATRANS project:

URBAN TRANSFORMATION IN SOUTH AFRICA THROUGH CO-DESIGNING ENERGY SERVICE PATHWAYS

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ACRONYMS

AMEU	ASSOCIATION OF MUNICIPAL ELECTRICITY UNDERTAKINGS
CBD	CENTRAL BUSINESS DISTRICT
CDM	CLEAN DEVELOPMENT MECHANISM
DEA	DEPARTMENT OF ENVIRONMENTAL AFFAIRS
DOE	DEPARTMENT OF ENERGY
	(FORMERLY KNOWN AS THE DEPARTMENT OF MINERALS AND ENERGY)
DSM	DEMAND-SIDE MANAGEMENT
EMSC	ENERGY MANAGEMENT STEERING COMMITTEE
FBE	FREE BASIC ELECTRICITY
GDP	GROSS DOMESTIC PRODUCT
GVA	GROSS VALUE ADDED
GHG	GREENHOUSE GAS
HVAC	HEATING, VENTILATION AND COOLING
HDA	HOUSING DEVELOPMENT AGENCY
IDP	INTEGRATED DEVELOPMENT PLAN
INEP	INTEGRATED NATIONAL ELECTRIFICATION PROGRAMME
IRP	INTEGRATED RESOURCE PLAN
KWH	KILOWATT-HOUR
LPG	LIQUEFIED PETROLEUM GAS
LTMS	LONG-TERM MITIGATION SCENARIOS
MFMA	MUNICIPAL FINANCE MANAGEMENT ACT
MSA	MUNICIPAL SYSTEMS ACT
MW	MEGAWATT
NCCRWP	NATIONAL CLIMATE CHANGE RESPONSE POLICY WHITE PAPER
NDC	NATIONALLY DETERMINED CONTRIBUTION
NDP	NATIONAL DEVELOPMENT PLAN
NMT	NON-MOTORISED TRANSPORT
NDC	NATIONALLY DETERMINED CONTRIBUTIONS
NDP	NATIONAL DEVELOPMENT PLAN
NGO	NON-GOVERNMENTAL ORGANISATION
PPD	PEAK PLATEAU DECLINE CARBON EMISSIONS TRAJECTORY
PV	PHOTOVOLTAIC
RDP	RECONSTRUCTION AND DEVELOPMENT PROGRAMME
SACN	SOUTH AFRICAN CITIES NETWORK
SALGA	SOUTH AFRICAN LOCAL GOVERNMENT ASSOCIATION
SANS	SOUTH AFRICAN NATIONAL STANDARDS
SEA	SUSTAINABLE ENERGY AFRICA
SSEG	SMALL-SCALE EMBEDDED GENERATION
STATSSA	STATISTICS SOUTH AFRICA
SWH	SOLAR WATER HEATER

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SOLAR-POWERED TRAFFIC

PHOTOGRAPH BY BABLU VIRINDER-SINGH FROM THE PHOTO ARCHIVES OF SUSTAINABLE ENERGY AFRICA



ABSTRACT

South African cities are highly reliant on energy, and access to and the provision of energy services affects urban energy transitions. While current energy systems have become unsustainable along social, economic and environmental criteria, contemporary energy transitions in South Africa become intertwined with numerous competing agendas, which can create trade-offs between growth, equity and sustainability. In an attempt to inform urban energy transitions in South Africa, this paper provides an overarching overview and analysis of the innovations within energy service delivery in 7 of South Africa's key urban centres, notably its metros and secondary cities, where majority of South Africa's population reside. The paper broadly assesses the extent of change underway that may have contributed to innovation in the urban energy systems taking place, the challenges affecting implementation that need to be addressed going forward and the possible contributions of the innovations to greening the South Africa economy. An enormous amount of work is happening at the municipal level in addressing energy access and energy poverty, energy efficiency, renewable energy and economic development. However challenges with institutionalisation, governance and finances hamper taking these efforts to scale. Vison, strong leadership, political support and cross-sectoral partnerships are required for the way forward.



PHOTOGRAPH BY BABLU VIRINDER-SINGH FROM THE PHOTO ARCHIVES OF SUSTAINABLE ENERGY AFRICA

1. INTRODUCTION

South African cities are highly dependent on energy, and access to and the provision of energy services affects urban energy transitions. While current energy systems have become unsustainable along social, economic and environmental criteria, contemporary energy transitions in South Africa have become intertwined with numerous competing agendas, which can create trade-offs between growth, equity and sustainability. In particular, South Africa's ability to generate sufficient power at a competitive price for economic growth while providing access to all its citizens, and at the same time distribute it in an equitable and affordable way and develop clean energy sources to mitigate against climate change, present considerable challenges. Although sustainable energy provision strategies and solutions as a way of promoting economic development and greening of urban economies have been adopted, much remains to be done to transform South African cities towards a more sustainable urban energy profile, which is in turn aimed at improving welfare and supporting economic activity, creating jobs and reducing carbon emissions.

Two thirds of South Africa's population resides in urban areas and 40% are located in the metropolitan municipalities.

To inform energy transitions in South Africa, this paper provides an overarching overview and analysis of the innovations occurring within energy service delivery in seven of South Africa's key urban centres, to inform energy transitions in South Africa (see Appendix 1). It does this in the context of cities, as two thirds of South Africa's population resides in urban areas and 40% are located in the metropolitan municipalities. Within this context, this paper provides case studies of selected cities, including metros and secondary cities, in terms of their demographic and energy profiles and to what extent they have introduced sustainable energy interventions and the governance structures in place to support low carbon energy transitions. The paper will broadly assess the extent of change underway that may or may not have contributed to innovation in the urban energy systems taking place, the challenges affecting implementation that need to be addressed going forward, and the possible contributions of the innovations to greening the South African economy.

This work forms part of the greater project called 'Urban Transformation in South Africa Through Co-Designing Energy Services Provision Pathways' (URBATRANS). The URBATRANS project aims to contribute to the transformation of South African cities towards a more sustainable and inclusive energy profile that support national goals of improving welfare, encouraging economic activity, creating employment, and reducing carbon emissions. The project investigates how the diverse challenges of energy provision in the South African context are inter-related within the broader, ongoing transitions to inclusive, secure and sustainable urban energy systems globally. This paper forms the basis for an ensuing report (titled Pathways to Urban Transformation in South Africa - The Case of the City of Johannesburg and Polokwane), which covers an in-depth case study analysis of two of the seven cities covered in this paper.

This paper begins with a background to the South African national and local energy context, followed by an overview of the seven cities. It then provides an analysis of the energy and emissions profile of these cities and of innovations taking place. The final section explores where the leverages for change/transformation towards a low-carbon future lie.

2. NATIONAL AND LOCAL CONTEXT

2.1 BACKGROUND: SOUTH AFRICA'S ENERGY CONTEXT

South Africa's economy and power sector, as has been well documented, has been built around a mineralenergy complex reliant on cheap coal (Fine & Rustomjee, 1997; SEA, 2014; Eberhard, 2011). This has fuelled the extensive mining of minerals, notably gold and platinum, and associated smelting production, and a successful synthetic fuel industry (coal to oil). Coal accounts for approximately 72% of the country's primary energy, thus energy and other resource-use patterns need to be addressed in order to move towards a sustainable, lowcarbon and equitable country. This is a substantial task for a country with an economy which derives 93% of all its electricity generation from coal, has an energy-intensive industrial sector and an energy sector responsible for 82% of total national greenhouse gas (GHG) emissions (DEA, 2014), placing South Africa among the world's top 12 largest carbon dioxide (CO2) emitters (DEA, 2014; CDIAC, 2012; Eberhard, 2011; DME, 2005).

93% of electricity generation from coal. Energy sector responsible for **82%** of total national greenhouse gas (GHG) emissions. DEA. 2014 South Africa is currently 64% urbanised. This figure is forecast to reach 70% by 2030 80% by 2050. Metros are growing at a rate of 2% per annum.

South Africa continues to experience rapid urbanisation, with approximately 64% of the country urbanised. Much of this growth is due to the migration of people from rural areas to the cities in search of employment and better living conditions. Urban populations are forecast to reach 70% by 2030 and 80% by 2050 (NPC, 2011; SACN, 2011, DCOG, 2013). The national census data of 2001 and 2011 reveal that the metros (South Africa's largest cities) are experiencing growing populations at an average rate of 2% per annum, and a concomitant increase in households at a rate of 3% on average annually.



South African cities are characteristically sprawling and low-density in form, which impacts strongly on resource allocation as well as efficiency and low-carbon imperatives. This urban form is historically rooted in apartheid's inequitable and segregated spatial-land distribution policies, but is also a consequence of modernist planning (Biermann & Van Rhyneveld, 2007; Ewing & Mammon, 2010; FFC, 2011; SACN, 2011).

The Reconstruction and Development Programme (RDP, 1994), the overarching national development programme instituted at the onset of South Africa's newly installed democratic government, promoted development through the expansion of infrastructure in poor communities with a focus on the delivery of basic services, including electrification and housing programmes. Regarding energy, the Integrated National Electrification Programme (INEP) resulted in 87% of the country being electrified today compared to 36% in 1994, an impressive and successful story despite not reaching universal access within the desired timeframe. The housing programme has led to the building of almost three million houses for the poor. However, because the success of the programme was measured by numbers (quantity) and the fact that it was driven by private companies whose central rationale was to make a profit, these homes were poorly built, with no ceilings or other forms of insulation and located on the urban margins where land is cheaply available. As a consequence, South African cities are socially exclusive, with the poor living on the distant margins experiencing persistently inadequate levels of service delivery and unable to access the opportunities of social resources and employment. Sprawl and severely polarised cities not only incur significant costs, but also constrain the ability of poor households to benefit from the economic opportunities and public services that cities provide, resulting in expensive and long transport journeys. The growth of the informal housing sector (shacks usually situated on land not zoned for residential development, but also including households in shacks in the backyards of formal properties) has contributed to the urban poverty landscape.

In 1994 **36%** had access to electricity Today the figure is approx **87%**

State of Energy in South African Cities 2015. Sustainable Energy Africa, Cape Town.

² Thermal efficiency, a measure of energy poverty 'relies on assessments of the condition of one's place of residence, focusing particularly on thermal comfort levels relative to social needs. This involves rating the thermal efficiency of dwelling units, since this influences the amount of energy required to heat the home to an acceptable standard and typically represents a notable determinant of domestic energy costs.' (DoE, 2012)

The State of Energy in South African Cities¹ report notes that cities are responsible for a third of total national energy consumption and about half of total electricity and liquid fuel use. Yet, cities cover just 4.5% of the land area. Due to the energy-intensity of these urban areas, cities are central to the trajectory of the national energy picture. Given the growth that many cities are predicted to undergo over the next few decades, there is a unique window of opportunity to apply sustainable planning and development principles in this process. This includes more efficient use of energy in all sectors, integrating renewable energy generation into developments, integrated transport and spatial planning approaches, sustainable housing delivery, and addressing energy welfare amongst low-income households. Effective implementation in these areas will result in increased employment and green economic growth, while concurrently improving equity and social benefits.

At the household level, people require energy for meeting their basic household needs, including cooking, lighting and space-heating. A lack of choice in accessing reliable, affordable and safe energy services is the way in which energy poverty manifests itself (UNDP, 2000). Although most households in South Africa are connected to electricity, many are still using a range of unsafe fuels largely for reasons of affordability (Reddy & Wolpe, 2014). According to a Department of Energy survey 47% of South Africans are considered energy-poor (DoE, 2013) as they spend more than 10% of their income on energy needs compared to wealthier households who typically spend 2-3% (SEA, 2006).

The Department of Energy 2012 survey on energyrelated behaviour identifies thermal efficiency² as another measure of energy poverty. DoE reports that almost a third (32%) of formal houses are thermally inefficient, compared to 86% of shacks and informal dwellings (DoE, 2012). The implication is that those residing in informal dwellings, often non-electrified, bear higher energy costs for space-heating due to energy-inefficient living quarters (DoE, 2012).

47% are energy-poor spending 10% of their income on energy **32%** of formal houses are thermally inefficient, compared to 86% of shacks and informal dwellings



PHOTOGRAPH BY CEDRIC NUNN FROM THE PHOTO ARCHIVES OF SUSTAINABLE ENERGY AFRICA

Energy poverty is also manifest in the persistent multiple fuel-use patterns displayed by poor households across South Africa, despite being electrified (Reddy & Wolpe, 2014). Almost 7 million households continue to largely rely on unsafe, unhealthy forms of energy such as paraffin, coal and biomass when they cannot afford to buy electricity (DoE, 2012). The pattern of fuel use by low-income households better resembles a portfolio of different energy sources at any time, and the varied fuels chosen often depend on budget, need, availability and preferences (i.e. a complex of social and economic factors determine household fuel use). Poor households often experience irregular and inconsistent sources of cash income, giving rise to expenditure patterns that do not allow for large discrete amounts to be spent on energy (e.g. through paying an electricity bill) but require purchasing of energy in small amounts (e.g. bucket of coal, litre of paraffin, prepaid electricity card for the minimum amount of R10). This enables the household to spend smaller amounts at a time, given their available income.

Almost 7 million households continue to largely rely on unsafe, unhealthy forms of energy such as paraffin, coal and biomass when they cannot afford to buy electricity. DoE, 2012 Tackling the urban profile in terms of sprawl, transport, access to basic services including energy, the reduction of poverty whilst paying attention to climate change, a low-carbon trajectory and sustainable development are major challenges for cities. Much is happening at the local level as influenced by international and national agendas. In the next section we examine some of the strategies and intentions in place and then detail what the cities are doing.

Cities are energy-intensive nodes and therefore the potential for transforming the energy and emissions profile of South Africa should not only be tackled at a national level, but also include interventions and policies at the local and urban levels. Sustainable Energy Africa undertook a study of 27 cities across South Africa including the eight metropolitan municipalities in 2015.

The study cities are home to 53% of the population, produce 55% of national GDP, are responsible for 40% of national energy consumption and contribute 39% of the country's GHG emissions. The modelling undertaken shows that a 38% reduction in carbon emissions is possible by 2050, relative to a Business as Usual scenario, if the cities adopt large-scale energyand transport-efficiency measures, as well as adding local energy generation to their electricity distribution grid. While reducing emissions associated with power production is largely outside of the direct control of cities and a long-term project, city governments have the opportunity to leverage their influence over nationaland regional-level energy supply and demand decisions. This is where the potential for transformation lies; this is where innovation is taking place. The question is how to take this to scale.

Sustainable Energy Africa undertook a study of 27 cities across South Africa including the eight metropolitan municipalities in 2015.

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2.2 NATIONAL

Since 1994, South African policy development has prioritised addressing the injustices of the apartheid regime, with a focus on the challenges of poverty, unemployment and inequality. Tackling the challenges associated with climate change have more recently taken prominence on the national government agenda, such that today the country has many national policies and plans focused on climate change and energy. These have included the National Climate Change Response Policy White Paper (NCCRWP, 2011), a Climate Change Bill that is under development (2018), the country's electricity masterplan for the next 30 years (Integrated Resource Plan, 2010), the Energy White Paper (1998), and the Energy Act (2008). Emerging national policy also now explicitly recognises the role of local government in shaping energy demand into the future, and pursuing a low-carbon development path. Many of the climateresponse interventions detailed in the NCCRWP relate specifically to powers and functions of local government. These include energy efficiency, management of the built environment, spatial planning, adaptation and the broad promotion of low-carbon economies.

It is important to outline a few of these policies that have guided the country's thinking. The Long Term Mitigation Scenarios (LTMS, endorsed by government in 2008) outlines three scenarios:

- growth without constraints;
- business as usual or current development paths; and
- 'required by science'

in order to provide the shift needed to align with international climate change targets and arrest the catastrophic effects of climate change (DEA, 2011).

The modelling undertaken shows that a **38% reduction in carbon emissions is possible by 2050**

(relative to a Business as Usual scenario) if the cities adopt large-scale energy- and transport-efficiency measures, as well as adding local energy generation to their electricity distribution grid.

The LTMS advocates a peak, plateau and decline (PPD) trajectory in carbon emissions reductions and this has continued to be used as a baseline for the country's strategic direction. The country's first National Development Plan 2030 (NDP, 2012) provides an overarching plan for the country and advocates the need to create jobs, grow the economy and substantially reduce inequality and poverty. It promotes achieving the PPD trajectory of GHG emissions and the concurrent need for a move to a less carbon-intensive electricity sector.

The National Climate Change Response White Paper (NCCRWP, 2011) was developed to address and manage climate change responses and mitigation through interventions that build and sustain South Africa's social, economic and environmental resilience. It recognises that many of the impacts and mitigation responses to climate change will take place at the local level and thus acknowledges that local government plays a crucial role in building climate resilience and mitigation through planning human settlements and urban development, providing municipal infrastructure and services, managing water and energy demand, and local disaster response, amongst others. It moves from a relative 'deviation from Business as Usual (BAU) to an absolute peak, plateau and decline greenhouse gas emissions trajectory range'.

South Africa's Nationally Determined Contribution (DEA, 2015; 2016) to global climate change talks to the developmental needs of the country (Caprotti, 2018) as well as the need to deal with climate change imperatives. It addresses three key themes, namely mitigation, adaptation and investment support.

2.3 LOCAL

The increased recognition of urban energy as a key thread in the national picture has led to a dramatic shift of responsibilities at local and national levels in recent times. To illustrate, energy issues at the local level, which were previously relegated solely to municipal electricity departments, have now been integrated into a range of service delivery and environmental departments at national level. Furthermore, in larger cities, new energy units have been established to plan and manage this key area.

Cities in South Africa derive their mandate to tackle energy and climate issues from amongst others, the Constitution, the White Paper on Local Government, and the Municipal Structures Act. This is not a clearly defined mandate, with both energy and climate response being substantially cross-cutting issues (energy and climate change response activities are located across a spectrum of municipal departments), but is implicit in the objectives of local government and the powers and functions accorded to local government in the Constitution.

Although overarching legislative powers reside with national government, city governments have a central role to play in managing energy consumption and GHG emissions. They can incentivise energy efficiency and promote renewable energy use and public transport. Indirectly they can influence city energy use through urban planning and economic development. Cities are substantial energy users through civic amenities and services, and can provide leadership through reducing their own GHG emissions. Emerging national policies now also explicitly recognise the role of local government in shaping energy demand into the future, and pursuing a low-carbon development path.

South Africa has many local-level policies and plans focused on energy and climate change. The challenge that remains, however, is the implementation of these plans, since municipalities are generally capacity- and resource-constrained, and need support to meet the new sustainable energy challenges they face, including around capacity building, technical support and information development, as well as assistance with the new institutional and regulatory requirements in relation to this growing field of work. The objectives and developmental duties of local government are set out in the Constitution and include: achieving sustainability, environmental protection, access to services for all, prioritising the poor, and social and economic development. It is the sphere of government closest to the communities it serves and is seen as the delivery arm of national programmes. The powers and functions of local government include air pollution, building regulations, electricity and gas reticulation, municipal planning, public works, municipal public transport and municipal roads, street lighting, water, waste removal, and stormwater management.





City governments have a central role to play in managing energy consumption and GHG emissions. They can **incentivise energy efficiency** and **promote renewable energy use and public transport**.

> PHOTOGRAPH BY BABLU VIRINDER-SINGH FROM THE PHOTO ARCHIVES OF SUSTAINABLE ENERGY AFRICA

and adaptation response. The survey also highlighted that climate change concepts need to be simplified (DEA, 2016). In addition, low-hanging-fruit projects need to be identified: whilst municipalities are carrying out a number of projects, there was an appreciation that there is still an opportunity to further raise awareness on 'easy to do projects' that municipalities can implement without substantial cost implications.

Climate change considerations need to be integrated and mainstreamed into local government planning processes, and awareness generally needs to be improved. Municipalities have a range of tools, powers and functions through which to address energy efficiency and renewable energy. They have a sizeable role to play in their own operations and service delivery processes, in areas like building and operations management, and procurement. Municipalities also have the power to create by-laws in their jurisdictions in line with the objects and development duties of local government and in line with national legal frameworks and policy directions. Many of the new policy directions and programmes relate to energy demand (on-ground consumption). These new approaches, alongside technology disruptions, such as small-scale embedded generation, have brought the issue of energy planning strongly into the domain of local aovernment.



PHOTOGRAPH BY MARK LEWIS FROM THE PHOTO ARCHIVES OF SUSTAINABLE ENERGY AFRICA

3. OVERVIEW OF SEVEN SOUTH AFRICAN CITIES

3.1 INTRODUCTION

Given the energy-intensive nature of cities, and the significant influence cities have over energy use in their areas of jurisdiction, they are central to changing the energy and carbon emissions trajectory of the country (SEA, 2015). The cities selected for this overview comprise four metros and three secondary cities. Secondary cities tend to be smaller in size, population and in contribution to the national economy than the larger metros (Turok & Borel-Saladin, 2013; SACN, 2012). The reason for considering both metros and secondary cities is that the latter are growing, and show a higher population growth, at an average rate of 2.3% per annum, compared with the 2.0 rate of metros (Stats SA 2001; 2011). Many of these cities are still taking shape and appear to provide an opportunity for people seeking a better life. The information presented below is based on 2011 Census data and is supplemented by data collected by SEA for the 2015 State of Energy Report.

Secondary cities are growing at an average rate of

2.3% per annum.

DEMOGRAPHICS

Large Metro

Population **4.4 Mil**

Informal

households

17%

31%

Unemployment

Population growth of

3.2% 2001-2011

Indigent households 52%

(income less than

R3200 per month)

(based on using electricity for lighting)

3.1.1 CITY OF JOHANNESBURG – GAUTENG PROVINCE

The City of Johannesburg, a metropolitan municipality, was formed in 1886 after the discovery of gold and the Witwatersrand reef. It is the country's largest city. As the economic and financial hub of South Africa, Johannesburg generates 17% of the country's gross domestic product, mostly through the manufacturing, retail and service industry sectors. It is one of world's leading financial centres. It is also characterised by heavy industries, including steel and cement plants. City

Deep is an industrial and container terminal suburb of Johannesburg and considered one of the world's largest 'dry ports'.

Urbanisation rates in Johannesburg are the highest in the country (99.8%), and informal settlement growth sits at 1.6% on average per annum - the second highest of all metros (Stats SA, 2011). Rapid urbanisation, driven by employment and resource opportunities, has resulted in increased demand for basic services and has contributed to the growth of the informal sector (HDA, 2013). In terms of household energy use in the metro, among electrified households (using Stats SA, 2011 data which does not distinguish between formal and informal/illegal electricity connections), 91% use electricity for lighting, 87% for cooking, and 88% for space-heating, a clear

indication that multiple fuels are used. Many households do not heat space, rather using blankets. In unelectrified households, 76% of households use candles for lighting, while 18% use paraffin. In order to meet cooking needs, 87% of households use paraffin, while 7% use liquefied petroleum gas (LPG). For space-heating, almost half of households use paraffin, 26% do not use any fuel, 15% use wood, and 7% coal. Only 3% of households use gas for space-heating.



GOVERNANCE

The City of Johannesburg has progressive climate, energy and development policies and strategies in place as does Gauteng Province. These include a Greenhouse Gas Inventory, the Growth and Development Strategy 2040 (GDS 2040, 2011), which talks to a resilient and liveable society that provides sustainability for all its citizens, the Energy and Climate Change Strategy and Action Plan (ECCSAP 2012) and the recently developed Climate Change Strategic Framework (CCSF). This framework builds on the current ECCSAP and is the basis for the development of an updated comprehensive integrated climate change strategy and implementation plan as well as a guide on how to institutionalise and further mainstream the implementation of such strategies.

The City's Integrated Development Plan (IDP)³ includes flagship programmes such as the Corridors of Freedom transit-oriented development, Green and Blue Economy and Smart City Development. Johannesburg has clear climate change and mitigation objectives and goals which are encapsulated in the above documents

The IDP is a five-year overarching plan which local government is required to compile to determine the development needs of the municipality. The projects within the IDP are also linked to the municipality's budget.

Households that own a car 38%

Transport accounts for: 70% of energy consumption

31% of emissions (see appendix 2)

Electrification 91%

Built environment including industry accounts for:

30% of energy consumption

69% of emissions (see appendix 2)

and clearly defined in the GDS and informed by both national and Gauteng provincial strategies. The City has identified a 2050 carbon emission mitigation target of 43% below 2010 emission levels. The City realises that reaching these targets requires a mix of mitigation measures covering all the main emitting sectors (waste, water, energy, transport, spatial and human settlement development, buildings) and a comprehensive and aligned plan and verification cycle including measurement and data collection. However, although to data only the Department of Environment and Infrastructure Services has specific climate change responsibilities, they are very engaged and cooperative on climate change programmes. Yet, the actions of this single department can have limited impact in other departments if no further integration and mainstreaming of climate planning takes place. From an institutional perspective, the City has a mayoral subcommittee on climate change which facilitates high level political decision making in regard to climate response.

FIGURE 1:

GAUTENG CITY REGION: CITY OF JOBURG, EKURHULENI AND TSHWANE METROPOLITAN MUNICIPALITIES SOURCE SACN, 2011

INNOVATION

The City of Johannesburg, through its electricity department (City Power) implemented a mass rollout of solar water heaters for low-income households in the metro over the period 2011-2014. This project was funded in part through a) carbon finance funds⁴ and b) City Power charging a local demand-side management levy of 1–2c/kWh to customers consuming more than 500 kWh of electricity per month.

The main objectives of the programme were to achieve the social goals of universal access to clean and affordable energy services, alleviate energy poverty, and promote enterprise development, job creation and skills development. More importantly, as a result of the national electricity supply crisis afflicting the entire country, this programme aimed to reduce peak time (in the mornings and evenings) electricity demand by displacing an estimated 500 kWh of energy required for boiling water using a kettle or an electric stove per household per year.

City Power in collaboration with the Water Department installed 200 litre capacity passive solar water heaters (SWHs) in close to 80 000 households. The Water Department was responsible for the plumbing required in the installation process, as the SWHs were low-pressure systems. Based on the selection criteria employed by the municipality, which targeted low-income electrified households living in government-delivered RDP homes with a water supply, the communities chosen to receive SWHs were Kanana and Ruster-Vaal. The programme has subsequently been extended to other low-income areas of the metro largely within City Power's jurisdiction of electricity distribution,⁵ as well as to households based in the rural parts of the municipality, in an effort to reduce deforestation for firewood used as a fuel to boil water. City of Johannesburg is committed to improving the delivery of energy services to households in informal settlements. To this end it has embarked on the provision of a combination of grid electricity and alternative and renewable energy in an affordable and sustainable manner. The cost borne by the municipality in providing a grid connection is estimated to be R25 000 per household and the ongoing monthly operational costs to maintain the connection is an additional R900 per month. It was observed that the provision of electricity alone was not feasible for low-income households, as they cannot afford to purchase electricity by the middle of the month despite receiving a subsidised electricity tariff. Providing a combination of energy solutions, which include grid electricity, solar energy and LPG, is a more sustainable approach to enabling low-income households meet their energy demands. The project forms part of the City of Johannesburg's ongoing efforts to avoid dangerous illegal electricity connections, and electricity theft by households who have no access to the national grid.⁶

The implementation of this portfolio of energy solutions is currently underway in two informal settlements, Thembelihle and Lawley Station. Households are supplied with grid electricity, a solar PV system with a battery, and an LPG stove.⁷ For grid electricity, the approach is to install an electricity connection with a grid limited electricity supply of 20Amps to prevent overloading and collapse of the network, and households are advised to use clean alternative energy technologies (LPG and solar PV) to supplement their electricity use. The internal house service point is installed with a ready board with a limited 20Amps capacity circuit. The ready board is equipped with an efficient LED light rather than an incandescent light or compact fluorescent light bulb.



City Power in collaboration with the Water Department installed 200 litre capacity passive solar water heaters (SWHs) in close to **80 000 households**.

The programme has been extended to other low-income areas in an effort to reduce deforestation for firewood.

> PHOTOGRAPH BY MARK LEWIS FROM THE PHOTO ARCHIVES OF SUSTAINABLE ENERGY AFRICA

With regards to the solar PV, integrating it with a microgrid system established in these settlements secures energy demand while at the same time alleviates the load pressure on the local and national grid, particularly during the morning and evening peak times when electricity demand is greatest.

The LPG package is introduced to households to meet their cooking and water-heating energy needs. It includes a two-plate gas stove and a 6 kg cylinder. Using an e-vending system, households can redeem the Free Basic Alternative Energy subsidy enabling the purchase of LPG from a local business, making it easily accessible, and stimulating the development of emerging entrepreneurs to trade gas locally.

In Johannesburg, transport accounts for 70% of all energy consumed. In an effort to address transport efficiency, the metro is encouraging public transport use and promoting transit-oriented developments.

As with many metros and most cities in the country, the transport sector accounts for the largest energy share of energy consumed. In Johannesburg, transport accounts for 70% of all energy consumed. In an effort to address transport efficiency, the metro is encouraging public transport use and promoting transit-oriented developments such as the 'Corridors of Freedom' project, which includes well planned transport routes linked to mixed-use development - high-density accommodation, supported by office buildings, retail development and opportunities for leisure and recreation. This development was also undertaken with the objective of facilitating social transformation through not only addressing transport efficiency but also enabling the improvement of livelihoods, social cohesion and economic inclusion and sustainability.

The metro has also rolled out a bus rapid transit system with increased travel routes, and established the fast

⁴ SEA; GIZ (2015). Review of best practice solar water heating implementation by local government.

⁵ City of Johannesburg (2015). Climate Change Strategic Framework for the City of Johannesburg.

Gautrain, which is geared more towards high income users. Both these transport modes are subsidised by government. The heavily utilised large minibus taxi industry is, however, not subsidised, which is significant given that is the dominant mode of transport for the poor. When looking in more detail at transport it is clear that most energy consumption takes place in private transport sector.

The City of Johannesburg's Environment and Infrastructure Services Department (EISD) is engaged in new approaches and open to collaborative/partnershipdriven work. This department informed the City's green bonds initiative, which aims to contribute to the GHG reduction targets set by the City of Johannesburg in line with the National Climate Change emissions reduction targets. The intention is that the green bond will finance programmes such as Eco Mobility, an integrated waste management system, the re-use of water, and implementation of renewable energy projects.

City Power has an energy efficiency and demandside management (EEDSM) department which has developed a number of programmes in this regard. Projects underway include the following: a 7.5 MW of small-scale embedded solar photovoltaic generation has been commissioned; funding is available for efficiency retrofits on heating, ventilation and cooling); a waste characterisation study is in progress and planning to undertake its own electricity masterplan with a forecast of 30 years.

The City of Johannesburg won the 2017 South African Greenest Municipality Competition Award, in the metro category. The focus is on sustainable development, including efficient waste management practices, efficient energy use, sustainable water use, public participation and best practice of municipal leadership.

The metro is engaged in local and global partnerships which play an important role in its global position and to this end it a C40 city and a member of the Compact of Mayors.

The projects and programmes in place are innovative but also pose challenges for the city. Given its position in the South African economy and contribution to national GDP, it is essential to include Johannesburg in the indepth case study research. It provides a good example of how energy experiments can contribute to the city's broader transformation, the potential impact on national policy decisions and the country more generally.

⁷ Paul Vermeulen, City Power (2016). Energy provision to low income areas. Presentation at Urban Energy Network Meeting.

⁶ https://joburg.org.za/index.php?option=com_content&view= article&id=11793&catid=88&Itemid=266

3.1.2 CITY OF TSHWANE - GAUTENG PROVINCE

Tshwane is a metropolitan municipality located in the north of Gauteng Province, and comprises over a third of the province's area. In 2010, the municipal land area expanded almost threefold from 2,198 km² to 6,298 km² after the incorporation of Metsweding (Stats SA, 2011). The metro now occupies 39% of the land area of Gauteng province. The City suffers from urban sprawl and inequality, which was largely shaped by apartheid but persists today - as with most South African metros. Many residents live in informal settlements far from the city centre and economic opportunity.

industry is a key role-player. According to the Automotive Industry Development Centre, the municipality accounts for 40% of South Africa's automotive output. Government

and financial sectors dominate, however, and are key drivers of economic growth. The gross value added (GVA) growth rate has increased on average by 4.55% per year between 2001 and 2011 on the back of the strong financial services sector.

Findings from a transport study conducted in Tshwane, reported in the South African Cities Network 2011 Cities Report, revealed the average length of car journeys to be twice as high as in cities such as London and three times higher for those using public transport; this is largely due to the density and spatial form of the city.

Many residents live in informal settlements far from the city centre and economic opportunity.

DEMOGRAPHICS

Large Metro

Population 2.9 Mil

Informal households

18%

Unemployment 31%

Population growth of 3.2% 2001-2011

> Indigent households

(income less than

R3200 per month)

48%

(based on using electricity for lighting)

GOVERNANCE

Tshwane developed a first State of Energy Report in 2005 and an Energy and Climate Change Strategy in 2006. At this time, this work was conducted within the Environmental Health Department, and the strategy intended to function through a cross-sectoral Sustainable Energy Committee. Ideas raised in the Strategy around the creation of an institutionalised unit that would combine the (new) functions of air quality control, climate change and sustainable energy were superseded by the establishment of the City Sustainability Unit (CSU) in the Office of the Mayor, in 2013.

With the aim of addressing sustainable development and climate change, this unit provides the institutional 'home' for sustainable energy leadership and management within the City. The location of the Unit, centrally placed under the Mayor and Deputy City Managers, of Strategy Development and Implementation Planning, and of Operations and Service Delivery, respectively, offers a strategic opportunity to introduce sustainable energy into the crucial area of planning, as well as into all functional areas of the City.

The CSU derives its mandate from the Tshwane Vision 2055: Towards a Resilient, Low Carbon and Resource Efficient City. Under the leadership of the Chief Sustainability Specialist, the Unit has two operational areas which reflect the policy framework (notably the Framework for a Green Economy Transition, 2015): mitigation and adaptation. In line with the City's Framework for a Green Economy Transition, the area of



PHOTOGRAPH BY MARK LEWIS FROM THE PHOTO ARCHIVES OF SUSTAINABLE ENERGY AFRICA



Households that own a car 44%

Transport accounts for: 54%

of energy consumption

18% of emissions (see appendix 2)

Electrification 89%

Built environment including industry accounts for:

46% of energy

consumption

82%

of emissions (see appendix 2)

sustainable energy is held within the operational areas of mitigation. The City's sustainable energy goals are detailed as moving towards a lower-carbon city with access to affordable, safe, clean energy for all. It includes a list of initial strategic priorities and actions.

In addition, Tshwane has recently developed a Climate Change Response Plan, which is informed by the Vulnerability Assessment to Climate Change, the annual Greenhouse Gas Inventory, and an updated State of Energy Report. Important areas of adaptation focus reflected in the Framework for a Green Economy Transition.

Framework includes:

Sustainable agriculture and food security

Community health and social development

Ecosystem goods and services

Agriculture and food security

A number of departments in the metro are already engaged in sustainable energy actions and the City has comprehensive energy data. Over the years a number of important sustainable energy actions have been implemented across the City.

THE CITY'S FRAMEWORK FOR A GREEN ECONOMY TRANSITION ARTICULATES A RANGE OF AMBITIONS WITH REGARD TO RENEWABLE ENERGY AND ENERGY EFFICIENCY.

BIOGAS-TO-

life span.

ELECTRICITY:

BRONKHORSTSPRUIT

This plant has an installed

anticipated initial 20-year

SEWAGE METHANE

FROM WASTEWATER

TREATMENT WORKS

wastewater-to-electricity

plants at present.

Tshwane does not have any

capacity of 4.6 MW, and an

BIOGAS PROJECT

A NUMBER OF PROJECTS ARE EITHER IN OPERATION OR UNDER CONSIDERATION:

INNOVATION

LANDFILL GAS POTENTIAL

According to a recent Integrated Waste Management Plan the City disposes of some three million tonnes of waste each year. There is thus huge pressure towards waste minimisation, as landfill space is running out.

SOLAR PV - ROOFTOP

Examples of innovation taking place in the City

include the Green Building Development By-

law with mandatory green building development

standards and the Green Buildings Incentive

scheme to encourage new buildings to surpass

the mandatory standards and adopt the promoted

standards. In addition, the Tshwane Compaction

and Densification Strategy is aimed at addressing

the need for densification and compaction within

the Tshwane metropolitan area.

Due to falling solar photovoltaic (PV) prices globally and rising local grid power prices, there has been an acceleration of rooftop solar PV installations.

The City is reviewing regulations and the revenue impact for SSEG rollout.

HYDROPOWER

A 15 kW hydropower system has been operating at Tshwane's Pierre van Ryneveld reservoir since 2011. To promote energy efficiency, the metro has rolled out solar water heaters. There is substantial scope for widespread rollout of this technology in all housing income groups. All new middle- and high-income households are obliged to utilise efficient water-heating systems in terms of the national building regulations SANS 10400 XA (this can be through solar water heaters or heat pumps). Government incentives to middle-to-high-income households for the use of solar water heaters were terminated in April 2015, and there are no indications that they will be reinstated. The Department of Energy does expect the low-income solar water heater programme rollout to be funded by National Treasury, with budget allocations allowing around 40 000 systems to be installed nationally per year for the next three years.⁸ The timeframes and mechanisms for this large-scale implementation are not yet clear.

Middle-to-high-income households spend approximately 42% of their annual electricity consumption on waterheating, by far the most energy-intensive end-use, followed by cooking at 22% and swimming pools. Solar water heaters therefore offer enormous potential to reduce the electricity demand within this sector.

Tshwane has undertaken a range of energy-efficiency interventions in its municipal operations, including building retrofits, streetlight retrofits, and the purchase of electric vehicles for its fleet.

Heater Programme Available Business Opportunities. 23 June 2015.



PHOTOGRAPH BY BABLU VIRINDER-SINGH FROM THE PHOTO ARCHIVES OF SUSTAINABLE ENERGY AFRICA

The metro has comprehensive integrated transport and spatial development plans, including a non-motorised transport plan. As with most metros in South Africa, the transport sector accounts for the greatest share of energy consumed in the municipality relative to the other sectors, and is a significant source of GHG emissions. In Tshwane, transport accounts for 54% of total energy use and 23% of GHG emissions. Although electricity sales decreased as a result of the recession, load-shedding and price hikes, transport fuel consumption had been less affected. Sustainability in this sector is therefore amongst the most important areas of focus for the City.

The following targets are listed:

- Walking and cycling should be key components of Tshwane's integrated transport system with 15-20% of all daily trips over 2km to be done through cycling and 50% of all trips less than 2km to be achieved through walking.
- Work trips using public transport should increase from the current 47% to 80% of all motorised trips.

The metro is engaged in local and global partnerships and to this end it a C40 city and a member of the Compact of Mayors.

Department of Energy presentation by Khanyiso Zihlangu: National Solar Water

3.1.3 CITY OF CAPE TOWN – WESTERN CAPE PROVINCE

Cape Town is a metropolitan city in the Western Cape, with a small industrial sector but a larger commercial (particularly finance) sector. It also has a very large tourism sector. Energy consumption is high and there remains much poverty within the City. Cape Town International Airport is the secondbusiest in South Africa (after O. R. Tambo Airport in Gauteng Province).

FIGURE 2:

CITY OF CAPE TOWN METROPOLITAN MUNICIPALITY SOURCE SACN, 2011

Cape Town has several large informal settlements located on the periphery of the City, far from resource opportunities, while the far less populated central and southern areas are in close proximity to employment opportunities. As documented in the SACN 2011 State of Cities Report, the combined population of the southern and northern suburbs of Cape Town is less than that of Khayelitsha, a predominantly poor township.



DEMOGRAPHICS

Large Metro

Population

3.7 Mil

Informal households

20%

Unemployment **31%**

Population growth of **2.6%**

2001-2011

Indigent households **47%**

(income less than R3200 per month) Transport accounts for:

65% of energy consumption

Households

46%

that own a car

Electrification

(based on using

94%

electricity for

lighting)

35% of emissions n (see appendix 2)

Built environment including industry accounts for:

35%

of energy consumption

65% of emissions

(see appendix 2)

GOVERNANCE

The City of Cape Town has been one of South Africa's leading local governments with respect to energy and climate change work that seeks to address climate change in a growth-oriented manner. New policies and planning tools have been put into place that now set the stage for game-changing actions to be taken on climate change. The City adopted the first Integrated Metropolitan Environmental Policy (IMEP) in Africa in 2001. This policy formed the foundation for an environmental management strategy, outlining how the City intended to implement its commitment to the principles and underlying approaches to sustainable development and giving direction to local government's activities and programmes. Encouraged by the IMEP, the City of Cape Town published its initial Cape Town State of Energy Report in 2003 and updated it in 2007, 2011 and 2015. These reports provide valuable information on where, how and why energy is consumed across the metro-region, along with the associated carbon emissions. The 2003 energy baseline data and the 2001 IMEP became key ingredients in the City's pivotal Energy and Climate Change Strategy, which was adopted in 2006 and has been updated. The Strategy set out concrete sustainable energy objectives, targets and measures, and activated supportive institutional reforms. The City also developed an Energy and Climate Action Plan (ECAP), which was adopted by Council in May 2010.



In order to augment the ECAP with an assessment of different future development paths for the local and national energy sectors, the City of Cape Town undertook a strategic energy modelling initiative, called the Cape Town Energy Futures project, from 2009 to mid-2011. This work, known as the Energy Scenarios for Cape Town project, presented a comprehensive analysis of current and projected metro-wide energy use based on an extended and up to date dataset of energy consumption, supply mix options, costing data and energy use trends. It was updated in 2016 and built on the LTMS approach. Using the above projections, the City has identified energy-efficiency interventions including electricity, energy access, transport and renewable electricity supply as the optimum way forward for a secure energy future for Cape Town.

More recently (2017), the City has undergone a restructuring process and has set up an Energy Directorate with two divisions; Sustainable Energy Markets, and Electricity Generation and Distribution (formerly the Energy Office and Electricity Services Departments). The Sustainable Energy Markets Department is new and gearing up in scale and covers (1) generation and efficiency in municipal operations (most new work is captured here), (2) promotion / enabling renewable energy and energy efficiency, (3) low-income energy service delivery, and (4) data management and integration.

ENERGY-EFFICIENCY MEASURES IN JOE SLOVO SOCIAL HOUSING DEVELOPMENT

PHOTOGRAPH BY BABLU VIRINDER-SINGH FROM THE PHOTO ARCHIVES OF SUSTAINABLE ENERGY AFRICA

WORK AREAS		City procurement and operations	Low income household energy services	Energy efficiency	Renewable energy development	Low carbon development	
PROJECT AREAS		Supporting municipal retrofit projects; Monitor internal energy consumption; Training internal building and facilities management	Developing city strategy and implementation mechanisms for integrated household energy services	Communication and campaigns; Monitoring of city's Green Building regulations	Support sector departments to facilitate private sector RE development and pilot municipal RE projects.	Facilitating link between City Planning and Transit goals	
REAS	Policy and regulation	Developing policies for Internal Resource Management, Green Procurement, Development Planning; Engagement (with the relevant sector department) in national planning and regulation that may have an impact on local energy objectives.					
ATIC AF	Finance	Seeking additional funding to drive the new area of work, e.g. climate funds, green economy funds; Exploring revenue models and engaging with City Finance around new, resource efficient-oriented revenue models.					
THEM/	Partnerships	Ongoing engagement in national and international forums relating to climate mitigation and sustainable energy; Developing partnerships for implementation with the private sector and with academia in relation to innovation.					
ITTING	Data	Holding and developing the data bases that relate to the energy and GHG mitigation indices and targets and undertaking the necessary reporting to global and national platforms.					
ISS CU	Green economy	Align with the Green Economy initiatives in the City, as well as in the province and nationally; build and enhance the economic/job creation dimensions of the sustainable energy strategy.					
CRC	Research	Unlocking location specific implementation barriers and developing innovative approaches relating to the legal, financial and technical aspects of sustainable energy implementation.					

al planning in the City is closely informed and nced by a large body of transit oriented design

TABLE 1:OVERVIEW OF WORK AREAS AND THEMES OF THE FORMERENERGY AND CLIMATE CHANGE UNIT OF CITY OF CAPE TOWN

INNOVATION

Cape Town has many dynamic and progressive projects underway which demonstrate a strong focus on developing new energy and climate change approaches. It has been able to do this through strong collaborative partnerships with other organisations and global networks such as C40 and Compact of Mayors. In addition, it has for a number of years had strong champions in place to spearhead strategy, mayoral endorsement, funding and implementation of projects – some of which are highlighted below.

Under the energy efficiency programme it has introduced ceiling retrofits for low-income government-delivered homes – initially all government housing was built without ceilings which has a huge impact on thermal efficiency, health and dust from high winds in coastal areas.

An Energy Efficiency Forum has been initiated for the commercial sector; it was established in 2009 and has over 1000 members. The forum was a response to power

outages at a time when there were electricity shortages and was set up to help maximise energy efficiency. The forum brings in speakers and examples of best practice.

Some years ago the City produced a Smart Living Handbook, promoting household resource efficiency with respect to energy, water and waste.

With regard to energy poverty, the City has one of the highest informal electrification rates in the country and was able to do this through innovative measures such as introducing the maypole system of electrification. It has also developed a low-income household energy services strategy, which provides a holistic response to energy poverty in the city.

It has rolled out Waka Waka energy efficient lights to informal households and hot boxes for cooking, as an alternative energy efficient cooking technology Spatial planning in the City is closely informed and influenced by a large body of transit oriented design modelling work undertaken by the City Transport Department, which has a strong focus on making public transport viable through compact urban form.

The City is considering the following:

- Purchase from independent power producers of electricity generated from renewable energy
- Generating its own electricity from renewable energy
- Installation of solar PV on municipal buildings
- Energy efficiency in its own operations, e.g. pumps, motors etc
- Promotion of solar PV small-scale embedded generation
- Developing an electricity trading and wheeling framework
- Developing an electric vehicle framework
- · Regulations and by-laws for IPPs
- Think-tanks and task teams covering some of the above areas



JOE SLOVO SOCIAL HOUSING DEVELOPMENT

PHOTOGRAPHS BY BABLU VIRINDER-SINGH FROM THE PHOTO ARCHIVES OF SUSTAINABLE ENERGY AFRICA



The projects and programmes in place are innovative and provide a good example of how energy experiments can contribute to the City's broader energy and low-carbon development transformations, the potential impact on policy decisions and the country more generally. A challenge for the City lies in implementation, particularly with regard to funding and resource capacity.

3.1.4 ETHEKWINI – KWAZULU-NATAL PROVINCE

eThekwini is a metro in KwaZulu-Natal, home to the busiest container port in Africa. King Shaka International Airport is the third-busiest in South Africa. The metro has a large tourism sector, and strong manufacturing, tourism, transportation, finance and government sectors.



FIGURE 3: ETHEKWINI METROPOLITAN MUNICIPALITY SOURCE SACN, 2011

PHOTOGRAPHS BY BABLU VIRINDER-SINGH FROM THE PHOTO ARCHIVES OF SUSTAINABLE ENERGY AFRICA

DEMOGRAPHICS

Large Metro

Population

3.4 Mil

Informal households

16%

Unemployment 40%

Population growth of 1.1%

LANDFILL-GAS

TO-ELECTRICITY

ETHEKWINI

CDM PROJECT

2001-2011 Indigent households

59%

(based on using electricity for (income less than R3200 per month) lighting)

Households

33%

that own a car

Electrification

90%

Transport accounts for:

67% of energy consumption

45% of emissions (see appendix 2)

Built environment including industry accounts for:

33% of energy

consumption

55% of emissions (see appendix 2)

its kind in South Africa and set a precedent for local government participation in sustainable energy initiatives.

GOVERNANCE

Initially it started with the intention to increase awareness around saving electricity and promoting energy efficiency in the metro. A number of pilot streetlight retrofit projects and various metering interventions were implemented. Over the 2010-2014 period the mandate of the EO expanded significantly to include promoting renewable energy, climate change mitigation and non-motorised transport. The municipality also developed an energy strategy. In 2014 the EO and the Environmental Planning and Climate Protection Department jointly developed the Durban Climate Change Strategy, which further expanded the mandate of the EO to respond directly to the challenge of climate change mitigation. The Internal Energy Management Policy identifies opportunities for energy reduction and saving as well as the generation of green energy.

The eThekwini Municipal Energy Office (EO) was

established in 2009 in response to the National Power

Conservation Programme of 2008. It was the first of

The municipality is in the process of mainstreaming climate change response into each department.



Six flagship programmes have been identified in the strategy:

Adaptation Waste

Management

Transport

Renewable Energy

Water Conservation and **Demand Management**

Energy Efficiency and Energy Demand Management Flagship Programmes

Ethekwini is also known for setting the standard in the country for its GHG inventory, which it updates on an annual basis.

Ethekwini is also known for setting the standard in the country for its GHG inventory, which it updates on an annual basis.

The municipality is also part of the KZN Provincial Climate Change Compact that was initiated by the municipality's Environmental Planning and Climate Protection Department. In addition, the municipality is part of the 100 Resilient Cities programme, is a signatory to the Compact of Mayors and is a C40 city.

INNOVATION

The EO's programme is aimed at promoting embedded rooftop solar PV generation in eThekwini and establishing an example for the private sector and other municipalities to follow. Approximately 500kW of solar photovoltaics will be installed under this contract on the rooftops of various municipal buildings within the Durban CBD.

The primary aims of the project are to:

- provide opportunities for learning about photovoltaic installations for municipal officials and the public; and
- showcase that eThekwini Municipality is leading by example in adopting renewable energy technologies.

The EO has also developed a financial model to assist investors and solar energy professionals to estimate costs and benefits of a PV solar installation.

The Durban Solar City Framework has given rise to piloting a 'solar city' concept to promote the uptake of solar technologies in South African cities. The project commenced in April 2013 and is near completion. It seeks to make solar photovoltaics more affordable to households and businesses. As part of this project, the Durban Solar Map was developed as an outreach tool (http://www.durbansolarmap.co.za/). It is an interactive website to improve the level of awareness and information that allows property and business owners in eThekwini to assess the solar radiation potential of their rooftops for the installation of solar PV panels and also connect them with solar energy professionals.



The Green Corridor project is a reforestation project in the buffer zone to enhance the area and mitigate GHG emissions from the landfill site. The project is spearheaded by the Environmental Planning and Climate Protection Department.

Solar-powered traffic lights were installed at three intersections in preparation for COP 17. The eThekwini Municipality has participated in the Department of Energy's EEDSM programme since 2010 and funds from this programme have been used for the retrofit of energy efficient traffic and street lights, and building lights as well as energy management.



The Durban Solar City Framework has given rise to piloting a **'solar city'** concept to promote the uptake of solar technologies in South African cities.

> PHOTOGRAPHS BY BABLU VIRINDER-SINGH FROM THE PHOTO ARCHIVES OF SUSTAINABLE ENERGY AFRICA



In terms of the Municipal Internal Energy Management, an Energy Management Steering Committee (EMSC) has been constituted with membership representing each of the entities responsible for major energy use within the municipality. The EO will establish a system of electricity monitoring that will provide up to date and accurate information to municipal departments on their electricity use. An energy intervention finance competency will be established at the Energy Office to assist departments to secure funding for energy management interventions identified by the EMSC.

The Shisa Solar programme targets the upper-income group. The programme, which began in 2010, provides assistance to the residents of the eThekwini Municipality by simplifying the process of installing a solar water heater. The programme also provides an incentive by offering a discount if installation is done via it. So far, over 4000 people have registered on the site, with the numbers increasing daily.

As for non-motorised transport, an increasing network of cycling tracks has been constructed in the Durban CBD and other parts of the city, with the goal of making cycling safer and more attractive. A shared bicycle project for municipal staff and councillors has been established, with the aim of encouraging municipal officials to use bicycles rather than cars to travel between municipal buildings in the CBD. One bicycle station has been set up at the City Engineers' Complex and further stations are planned at City Fleet and City Hall. The metro has a City Fleet Energy Efficiency Plan with a focus on fuel consumption

The eThekwini Eco-Industrial Park Programme promotes cleaner production, pollution prevention, energy efficiency, renewable energy and inter-company partnering; and also works to develop an eco-industrial park that actively promotes the green technologies and services.

The KwaZulu-Natal Sustainable Energy Forum (KSEF): In 2013 the EO, in consultation with key stakeholders, initiated the process to establish KSEF as a not-forprofit-company. The mission of KSEF is to facilitate the development and growth of the sustainable energy sector in KwaZulu-Natal through information dissemination, and facilitation of networking within the sector and the implementation of enabling projects.

Clean development mechanism (CDM) registration: The objective of the project was to develop and implement a clean development mechanism for the Low Cost Solar Water Programme. The project saw the development of the first programme of actions CDM for a municipality in South Africa. The actual CDM registration took place in 2013 with crediting period to 2020.

The metro also promotes daylight savings amongst businesses as an energy-efficiency initiative.

3.1.5 NELSON MANDELA BAY METROPOLITAN MUNICIPALITY - EASTERN CAPE PROVINCE

The major towns that make up the Nelson Mandela Bay Metropolitan Municipality (NMBMM) are Port Elizabeth, Uitenhage and Despatch. The metro has a major port, automotive industry assembly plants and automotive companies, namely General Motors, Ford, Continental Tyres and Volkswagen with its largest car factory in Africa. The metro also has industries geared towards the motor vehicle industry, e.g. catalytic converters, batteries, etc.

There is a fairly large tourism industry. The Port Elizabeth International Airport is fourth-busiest in South Africa. From a spatial form perspective, NMBMM has a number of disparate settlements located guite far from the built-up area.



FIGURE 4: NELSON MANDELA BAY METROPOLITAN MUNICIPALITY SOURCE SACN, 2011

DEMOGRAPHICS

Large Metro Population 1.1 Mil Informal

households 12%

Unemployment 45%

Population growth of 1.4%

> 2001-2011 Indigent

households 59%

(based on using electricity for (income less than R3200 per month) lighting)

Households

36%

that own a car

Electrification

90%

Transport accounts for: **51%**

of energy consumption

22% of emissions (see appendix 2)

Built environment including industry accounts for:

49% of energy

consumption

78% of emissions (see appendix 2)

The six pillars of the vision are:

A Well-Run City	The Inclusive City
The Opportunity City	The Safe City
The Caring City	The Forward Thin

City rd Thinking City

The intention is the IDP will be the action plan to achieve the vision. The city wants to improve basic service delivery, job creation and revitalise business.

INNOVATION

Some 12 years ago NMBMM renamed their electricity department the Electricity and Energy Department, in order to reflect the inclusion of sustainable energy approaches into the traditional electricity service delivery mandate. Renewable energy and energy efficiency is now embedded within its IDP and in the job cards of city officials. Actual project delivery includes geyser ripple control, mass rollout of solar water heating within low-income housing projects and mid-high income household SWH rollout, efficient public lighting retrofit, wind farm development, efficient public building retrofit and conversion of landfill gas to energy. In partnership with the local university, NMBMM has also undertaken research into technical aspects of small scale renewable energy grid feed in. To date the municipality has approved regulations for small-scale embedded generation. In 2013 the municipality's Electricity and Energy Directorate introduced conditions for small-scale generators of renewable electricity and a standard application form. Despite challenges experienced along the way experienced, this represents a formidable change in approach to municipal energy services delivery. (SEA, 2015)

Renewable energy and energy efficiency ensure greater energy security, reduce dependence on carbon-based fuels and create jobs in local industries

At the heart of this commitment to a new approach was the strong conviction that sustainable energy service delivery is a core function of the City. For NMBMM, electricity reticulation is a narrow core function for municipalities. A far broader responsibility, it believes, is the developmental mandate - ensuring social, environmental and economic development into the future (as set out in the Constitution and the Municipal Systems Act), with energy at the heart of this. In this context, service delivery must ensure sustainability, which requires that municipal actions today should ensure the best and brightest 'tomorrow' for all citizens.

Given the challenges facing cities - climate change impacts and poverty, and the broad developmental mandate of municipalities as articulated in the constitution, with the core task of sustainable service delivery - NMBMM believes that developing a more

GOVERNANCE

The municipality is concerned to develop a green economy. The vision for the metro is 'an iconic, friendly ocean city driven by innovation, service excellence and economic development - a destination of choice'.

efficient, clean and diverse local energy sector is core business for all municipalities. Renewable energy and energy efficiency are seen to work to ensure greater energy security, reduce dependence on carbon-based fuels responsible for damaging local and global air pollution and create jobs in local industries, such as SWH manufacture or installation.

For many city staff – political and official – there is grave concern about financial responsibility: that the city will lose revenue from electricity sales and that renewable electricity is 'risky' and costly. NMBMM staff have countered this with the argument that the city is the residents. Making money is not the core business of the city, but providing the best service to residents is core business. If you can show that the new approach will mean that residents get better services in the longer term, probably cheaper, definitely more sustainable, then the City must do this.

Success in establishing this new approach within NMBMM was achieved through securing political conviction amongst councillors and top management. The motivation used included both internal and external 'drivers': global warming, energy security, building the local economy, job creation, and a 'green' image. Lobbying of top management included such key players as the Chief Financial Officer. High level City 'buy in' was crystallised in the form of a council resolution on alternative or renewable energy, endorsing the approach and associated actions throughout the City.

With political endorsement of the approach, city officials were able to initiate new projects. The Municipal Systems Act and Municipal Finance Management Act (MFMA), often cited as stumbling blocks to such developments, were viewed by NMBMM as challenges. Risk management is important for municipalities. However, the NMBMM approach was to start at finding the correct path for the municipality and then, using the regulatory framework supplied by the MFMA, work around the associated risk.

Far too often, NMBMM believes, fear of 'fruitless expenditure' accusations results in the legal and financial departments determining line function policy, rather than supporting policy. NMBMM believes that cities need to position themselves to meet the external challenges of energy security and climate change imperatives. Municipalities, in terms of the MFMA, must act in a financially responsible manner and minimise financial risk. But this should not mean that municipalities do not take the right action now to meet the challenges of the future. Given the severity of the external factors, NMBMM council and management believe strongly that the biggest risk lies in doing nothing.

Polokwane Municipality is located in central part of the Limpopo Province, in the Capricorn District. It is the administrative capital of the province, comprising 3% of the total surface area of the province. The spatial pattern of the municipality is characterised by separate settlements. At the centre is the CBD, which houses the industrial area and a range of social services - the economic drivers of the municipality - as well as the formal urban areas, and together accounts for 23% of the geographic area of the municipality. On the outskirts are rural/peri-urban settlements, the main clusters being Seshego, Mankweng, Molepo and Moletije, which account for 71% of the city. Much of this land remains held in traditional land tenure systems (this is land governed by traditional chieftainship systems). This presents particular challenges to the municipality in that it does not exercise authority over much of the land within its jurisdiction. This land is also effectively 'free' and not subject to rates and taxes, encouraging a dispersed settlement pattern that may challenge densification needed for greater investment in public transport systems. Although the physical composition of the City is largely rural/peri-urban, 89.4% of households reside in formal dwellings, and informality is a relatively small phenomenon.

Polokwane is a developing economy with Census 2011 data indicating 13.8% of households with no income and a further 55% of households earning an income of less than R3 200/month (i.e. under the poverty line). A total of 63.4% of the households earn an income of less than R76 400 per annum, within the lower-to-middle-income group (bracket). The total unemployment rate was 32.4% of the population in 2011 (StatsSA 2011).

It is the largest urban centre north of Gauteng. The economy is made up of agricultural produce: tomatoes, citrus fruit, bananas and avocados. The municipality has several major industries, e.g. Coca-Cola and South African Breweries. It also has a large commercial sector; with four of the largest banks in the country all having at least three branches in the City.

The total energy consumption within Polokwane municipality in the baseline year of 2011 was 22 Gigajoules (GJ) (inclusive of the large smelters), resulting in 3 mega tonnes of annual carbon emissions. Energy consumption per capita is on a par with metros in South Africa (at 35GJ/capita), and this would be lower if not for the presence of heavy industry. Industry, as a result of the smelters, accounts for the largest share of the energy consumed in the municipality. However, when these are excluded, the transport sector emerges as the largest energy-consuming sector, followed by industry, households/residential sector and the commercial sector (Polokwane, 2016).

Energy consumption per capita is on a par with metros in South Africa (at 35GJ/capita) and this would be lower if not for the presence of heavy industry. Households that have registered as indigent for basic services in the municipality receive 6 kilolitres of water per month from the Urban Regional Water Scheme. However, all households in rural areas receive free basic water. Free basic services relating to energy include provision of 100 kWh of electricity to indigent households. Between 2013 and 2014, 23 113 households received free basic services for electricity and water. This represents a decline in the number of households reached, but an improvement in the quantity of the service, from 50 kWh/month in 2011 to 100 kWh/month form 2013 (in 2011, 115 082 households received free basic water services and 27 000 households received free basic electricity).

Between 2013 and 2014, 23 113 households received free basic services for electricity and water



DEMOGRAPHICS

Secondary City

Population

629 000

Informal households

9%

Unemployment

0 Population growth of **2.2%**

2001-2011

Indigent households

47% (income less than R3200 per month) Households that own a car **27%**

Electrification

83% (based on using

electricity for lighting)

Transport accounts for:

49% of energy consumption

51%

of energy

consumption

24% of emissions (see appendix 2)

Built environment including industry accounts for:

76% of emissions (see appendix 2)

Polokwane's energy picture is dominated by electricity, which is used to meet 34% of the energy demand of the municipality and contributes 71% to carbon emissions. Petrol (18%) and diesel (13%) combined account for 31% of energy consumed, coal 17% and charcoal 16%. (Polokwane, 2016)

Within Polokwane's municipal boundary there are two industrial smelters, which contribute to Polokwane's industrial sector being the largest energy consumer at 56%, followed by the transport sector (31%), residential (9%) and commercial sector (2%). The government and agricultural sector account for a relatively insignificant share of the energy consumed in the City. The largest contributor to GHG emissions is the industrial sector (59%), followed by the residential sector (17%), transport (16%) and commercial sector (3%). Electricity losses (technical and non-technical) account for a sizeable 2% of total energy and 4% of total carbon emissions. This is a larger share of energy consumed than that consumed by the municipality in carrying out its functions, and tantamount to that consumed by the commercial sector (Polokwane, 2016).

PHOTOGRAPH BY MARK LEWIS FROM THE PHOTO ARCHIVES OF SUSTAINABLE ENERGY AFRICA

GOVERNANCE

Polokwane developed its first State of Energy Report and Energy Strategy in 2013 and in 2016 completed its Energy Strategy Update and Implementation Plan. The strategy is premised on the following vision:

'The ultimate in energy innovation and leadership through the provision of sustainable energy that is reliable, safe and affordable for all.'

The strategy identifies five key goals in line with addressing the challenges and opportunities for a sustainable energy future to 2020:						
Energy efficiency Public transport/NMT/						
Renewable energy	uewable energy Urban form					
Alleviating poverty	Institutional capacity					

These are supported by a detailed action plan for implementation. With the help of energy futures, modelling the strategy has been able to assess the impact of inaction ('business as usual'), as well as the impact of a range of sustainable energy interventions in the decades to come. A strong foundation of institutional capacity has been laid to take this work forward. The Energy Department, falling with the Engineering Services Directorate, continues to provide the institutional home for this work within Polokwane municipality. An interdepartmental committee drawn from the Green Goal team has supported the development and implementation of the strategy. This includes representation from Energy, Water and Sanitation, Waste Management, Local Economic Development and Tourism, and Facility Management. Transport and Spatial Planning have been consulted, but are not yet regular participants within the forum. This strategy is intended to become a more formal part of the Green Goal Team's mandate. The strategy document is in place but it is still to be formally approved by the council and launched.

Polokwane Municipality is involved in local, national and global sustainable energy partnerships and learning networks. Polokwane is a long-time member of the Association of Municipal Electricity Undertakings and has been involved in the national Urban Energy network convened by SEA-SALGA-SACN for a number of years.

INNOVATION

Polokwane municipality is already making enormous developments to address objectives of the goals of the strategy. A number of projects are currently in progress under different municipal departments to reduce energy consumption, while other projects have been completed. Some of the projects are specific to the municipality activities and others are external. Key achievements towards a sustainable energy future to date include those given below.

From an energy efficiency perspective the municipality has achieved a 100% retrofit (replacement) of all traffic lights with LED lights and installed double glazing windows in the civic centre. Many municipality-owned buildings are attempting to introduce energy-efficient technologies, such as water saving measures in the stadium, substantial retrofit of MV street lighting with efficient HPS lamps, replacement of inefficient motors with variable speed drives within the municipal water treatment system, with an average energy reduction of 42% and retrofit of municipal buildings with efficient lighting and sensors, efficient HVAC and water-heating systems.

The municipality has rolled out 1500 solar lights to schoolchildren in unelectrified townships. It has also developed a register, which identifies poor households illegible for receiving the Free Basic Electricity subsidy. The municipality has developed an alternative energy services service delivery model for low-income households, which include hot box rollouts, solar lamps, and the distribution of ethanol gel fuel. The project trains young women and is an enterprise development project.

The municipality has plans for a solar park and a solar water heater roll out. It is developing guidelines for small-scale embedded generation. Implementation of the bus rapid transit and non-motorised transport system: The majority of Polokwane residents use public transport (17%) and non-motorised transport (68%) for their

From an energy efficiency perspective the municipality has achieved a 100% retrofit (replacement) of all traffic lights with LED lights and installed double glazing windows in the civic centre. mobility. Only 27.3% of Polokwane residents currently travel by car. However, Polokwane, like many other municipalities, is experiencing a growth in the number of private vehicles, largely as a result of people preferring to use private cars instead of non-motorised or public transport. Since the transport sector already accounts for 35% of the total energy demand in the municipal area, the Polokwane Municipality needs to retain its existing high levels of public transport and non-motorised transport usage in order to minimise energy requirements and environmental impacts of transport.

The municipality won the 2017 Greenest Secondary City Award for its best practice relating to waste management, energy efficiency, water management, and public participation and community empowerment. Polokwane will receive R3.5 million, which will be utilised for funding of infrastructure projects aimed at the protection of the environment. It is important to recognise that the municipality is nurturing small business enterprise development and the green economy is being held and stimulated.

Energy consumption is relatively low compared to the metros, and poverty and high unemployment is prevalent. The projects and programmes in place that are innovative are largely in relation to energy poverty reduction and for those not connected to the electricity grid. This is important, as the City includes a substantial rural component. It is essential to include this City in the case study research as it provides a picture of a growing city with many challenges around capacity and poverty.

3.1.7 GEORGE – WESTERN CAPE PROVINCE

George Municipality covers a large area, from the Little Karoo in the north to the Garden Route in the south. It is renowned for its natural assets and beauty, including mountains and forests, wilderness areas, a varied coastline, lakes, rivers and estuaries. It is part of the Garden Route National Park and the Baviaanskloof Wilderness Area. The municipal area also includes farmlands and timber plantations along the coastal plain, fruit orchards in the Langkloof and arid grazing areas in the Little Karoo.

George is the capital of the Eden District (Garden Route), a popular holiday destination. It is the third-largest district economy in the Western Cape, after the City of Cape Town and the Cape Winelands District. The municipality has seen significant population and economic growth. In 2015 George was the largest contributor to employment within the district (36%) and 39.8% to the district's gross domestic regional product. This is higher than the provincial growth of 3.3% in the same period between 2005 and 2015 (WCG, 2017). It is characterised as a fast-growing secondary city, due to people being attracted to lifestyle/retirement as well as the rural poor seeking employment opportunities. With this rapid urbanisation, the municipality has struggled to keep pace with the increasing demand of its fast-growing population and the growing informal household sector.

The George economy and the region are interdependent. In its role as a service centre, it is also reliant on the region to generate demand for services and beneficiation that will stimulate its growth.

Poverty is a significant challenge for the municipality, with a large informal housing sector characterised by extreme poverty and a lack of access to a range of basic services including energy.

DEMOGRAPHICS

Secondary City

Population

194 000

Informal households

14%

Unemployment **30%**

Population growth of **3.2%**

2001-2011 Indigent

households

(income less than R3200 per month)

Households that own a car 43%

Electrification

91% (based on using

electricity for lighting) Transport accounts for:

44% of energy consumption

56%

of energy

consumption

tion (see appendix 2)

Built environment including industry accounts for:

85%

15%

of emissions

of emissions (see appendix 2)

GOVERNANCE

George is committed to developing climate change and sustainable energy interventions within the municipality as proposed by the Western Cape Province, but currently does not have a climate change strategy in place.

The municipality's governance system is fairly well established and plays a leading role in the province in driving economic growth. George Municipality's vision, as encapsulated in its 2017 – 2022 Integrated Development Plan (IDP), shows aspiration to being a City pursuing a sustainable future.

It has identified five strategic goals; namely, to				
Develop and grow George	Deliver affordable quality services			
Keep the municipality green	Engage in partnerships			
clean and safe	Ensure good governance and human capital in George.			

In fulfilling its local government service delivery mandate, the IDP commits the municipality to 'live our values, focus on citizens, work smart, act like owners and be the brand.' Besides fulfilling its constitutional mandate and complying with applicable legislation, the IDP commits the municipality to contribute to the development objectives of national and provincial government, as well as Eden District Municipality. Whilst the IDP is innovative and clear, the municipality needs to develop policies and budgets which are council approved in order to advance the potential that exists. In addition, the IDP talks to a sustainable city, but apart from a few initiatives described below there is very little on alternative energy service delivery options for poor households at an institutional level.

INNOVATION

George Municipality has identified solar water heaters and solar PV as renewable energy interventions, together with other energy-efficient technologies to integrate into the municipal service delivery functions at large. It has a leading integrated public transport system network, and is the first secondary city in South Africa to implement such a system. 'Go George' as it is known, is the result of a three-way collaboration between provincial and national government and George Municipality. An empowerment model was developed that sees current public transport operators who were operating minibus taxi or bus services in George forming a company to

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deliver the new scheduled bus service in terms of a contract. George Municipality, with the support of the Western Cape Provincial government, has entered into a 12-year contract with this new company, in line with national government policy. Part of the agreement is that other public transport services cease to operate on the Go George routes. Despite some challenges, it is a very successful project.

George has the first airport in the country to be powered by solar energy.

George Municipality has signed a power purchase agreement with the Central Energy Fund to purchase 8 MW of renewable energy from George's renewable energy generation plant using waste woodchips. A number of legislative and commercial issues are still being negotiated between the various parties concerned.

George is in the process of developing a SSEG tariff for residential and commercial customers. There are 20 connected customers.

In terms of energy-efficiency demand-side management measures in place, all streetlights and high-mast lights are retrofitted with energy-efficient lighting. There are plans for the replacement of public building geyser and air-conditioner systems next year with energy-efficient technologies.

The municipality is also investigating the functional design for solar PV at its own sites, as well as solar PV installations on government delivered low income houses.

The municipality has installed solar home systems in 1000 households in rural George, with funding from the national Department of Energy's EEDSM programme.

George has developed an indigent policy which focuses on the provision of support for the very poor households. The municipality has entered into an agreement with the landlords who have backyard dwellers living in makeshift shacks on their property, to receive the free basic electricity subsidy. This subsidy targets poor households, providing a certain amount of free electricity per month to support a small amount of lighting, heating, powering media appliances such as a radio or television. Similarly for farmworkers, the municipality pays the equivalent of 70kWh of electricity to Eskom (the electricity supplier to the rural areas of George) who in turn provide this electricity for free to the farm owner who passes it onto the farm worker in the form of a token. A third area of innovation is a pilot study where the municipality is providing LPG in rural areas through the FBE subsidy.

4.1 ENERGY AND EMISSIONS PICTURE

From recent research (SEA, 2015; 2016) it is clear that metros account for a sizeable portion of the energy consumed in the country. In the five metros examined in this report, the transport sector accounts for 65% of all energy consumed, whilst most carbon emissions (64%) are generated by the electricity sector (see appendix 2). This picture is typical of energy use and emissions in majority of the cities (see individual pie charts for each city in appendix 2).

As explained above, South African cities are some of the least dense cities in the world, and so are reliant on transport fuels for mobility, leading to high energy consumption in this sector. By comparison, the built environment - residential, commercial and industrial sectors - largely use electricity, which in South Africa is predominantly generated from coal and therefore a large source of carbon emissions. Smaller cities exhibit high carbon intensities similar in scale to that of the metros and often the result of large industrial and mining activities with high coal consumption demands. Generally, secondary cities account for a smaller proportion of national energy consumption compared to the metros. The five metros account for close to a fifth of national energy consumption (18%) and the secondary cities only 3%.

Gaining an understanding of the energy and emissions profile of the study cities helps to identify where the leverages for a low-carbon future might lie. It is evidently essential that cities address the spatial form and transport challenges they face. The other obvious challenge lies in energy efficiency and renewable energy options for generating electricity. Whilst growth is a pre-requisite in a developing context, with the triple challenges of high poverty, unemployment and inequality, it is clear that growth needs to be managed within a low-carbon framework. Metros are far more established in pursuing a low-carbon path, and therefore the scope for change could lie in the emerging secondary cities, which, to a large extent, are still unformed, leaving room for a new way of operating. However, from the descriptions above and evidence shown from research undertaken in South Africa, the metros and larger secondary cities are better resourced both financially and in terms of human resources to undertake innovation (SEA, 2011; SEA 2015; SACN 2015). In most cases, it is known from experience that it takes the drive of a champion or champion department for sustainable energy change to take place. This is where the potential for most innovation lies, as well as where there is evidence of energy experiments, strategies, policies and political commitment to a low-carbon future.



PHOTOGRAPH BY BABLU VIRINDER-SINGH FROM THE PHOTO ARCHIVES OF SUSTAINABLE ENERGY AFRICA

4.1.1 MUNICIPAL INITIATIVES IMPLEMENTED

An overview of six of the selected seven cities in particular demonstrates substantive initiatives taking place.

ENERGY EFFICIENCY

In the area of energy efficiency in the built environment many municipalities have implemented a range of projects and measures. Some municipalities have achieved this through sourcing funding from the energy efficiency demand side management grant (EEDSM) available to municipalities on application from the Department of Energy. To this end it is evident that energy-efficient lighting in municipality-owned buildings, street lights and traffic lights have been implemented. Many have rolled out efficient water-heating largely through SWHs. In lowincome areas these are low pressure units that do not have an electrical backup. Whilst national building regulations now include efficient water-heating in new build or large renovations, regular monitoring is not happening. Cape Town has adopted an accreditation programme for service providers and the City of Johannesburg has rolled out SWHs in low-income households, financed through a small levy on electricity tariffs. Energy-efficient building design has improved in terms of building regulations and also in the building of low-income housing. These government-delivered houses are now thermally efficient, are built with ceilings and, where electrified, have efficient compact fluorescent lightbulbs. In Cape Town, the Joe Slovo settlement is a good example of sustainable design being applied to low-income settlements.

TRANSPORT EFFICIENCY

Transport, as has been noted, is the highest energy consumer in the study cities. The low density of South African cities makes the financial feasibility of developing public transport systems problematic. Whilst transport efficiency and the integration of public transport and spatial planning are essential for cities, often they are not financially sustainable. National government in 2016 developed the National Transport Master Plan, which makes some grants available. Despite this, all cities discussed in this paper have some form of integrated transport plan and bus system in place. This includes Go George in George, and Bus Rapid Transit in Cape Town and Johannesburg. In some instances, bringing on board the minibus taxis has added to the challenge. A further difficulty is the split in responsibility between national, provincial and local governments regarding different public transport modes and where responsibilities lie. Cities need to explore all the different modes of transport available, including non-motorised transport, which might assist in addressing challenges. The City of Johannesburg has developed the Corridors of Freedom,

which is based on transit-orientated development and the future City, which concentrates on mixeduse development and motorised and non-motorised transport corridors. All cities in the study have integrated development plans and spatial development frameworks, all attempting in part to address these issues.

RENEWABLE ENERGY

South African cities are constrained in their mandate to generate their own electricity, although some cities, such as the City of Cape Town, are taking the Minister of Energy to court in order to enable them to purchase power from independent power producers and generate their own electricity from renewable energy. If successful, this would impact on other metros in the country. The costs of rooftop photovoltaics have globally been on the decrease and within South Africa this is also the case, making SSEG a competitive alternative to municipal electricity, particularly in light of increasing electricity costs. Some of the municipalities represented in this report have begun to explore tariffs and the impact on their revenue base in this regard. The regulatory standards and policy situation are being addressed, which is important for municipalities going forward. In some municipalities, rooftop PV installations are underway, such as Clearwater shopping mall in Johannesburg and Gallows Hill in Cape Town.

ENERGY ACCESS AND ENERGY POVERTY

All the cities in this report are focussed on dealing with the challenges of poverty and specifically energy poverty. From the data it is clear that whilst most cities have made substantial advances in electrifying households in their areas, none have reached the 100% target. Most cities are faced with the challenge of reaching universal access to electricity; this is partly related to the growth of informal settlements, housing being situated on land not deemed fit for municipal services, and to general housing and electrification backlogs. A further problem relates to affordability and many poor households continuing to use unsafe fuels. Some municipalities have made huge advancements in rolling out hot boxes, such as Polokwane. Many have looked at their indigent policies and been able to provide free basic electricity to more of their residents. The City of Cape Town has developed a low-income energy services strategy, undertaken ceiling retrofits in low-income housing, and integrated energyefficiency measures in housing developments such as Joe Slovo. Johannesburg has supported an alternative energy technology roll-out to low-income households, and many of the cities have managed to electrify some of their informal settlements.

Many municipalities have developed strategies and policies relating to sustainable energy and climate change. They have authority to do this and are mandated to deliver on basic services and to influence the development direction of their municipal areas, including land use planning, economic development, transport and infrastructure planning. As shown by the assessment of climate change mitigation implementation in municipalities conducted by the National Department of Environmental Affairs (DEA, 2016), municipalities are at different levels of advancement in terms of having climate-related plans in place. Some of this is to do with their size, how well developed and resourced they are and their level of economic growth. Whilst most metros are more advanced in terms of plans and strategies in place, some of the secondary cities are also making huge advances in this area.

In order to **substantively move towards a low-carbon future**, sustainable energy and climate change programmes need to be mainstreamed into municipal planning processes and institutionalised in their bureaucratic structures.

However, having strong frameworks and strategies is not sufficient. It is a good starting point but a huge challenge in South Africa relates to implementation. Many municipalities have innovative programmes and flagship projects underway, yet taking this to scale and institutionalising sustainable energy and climate change remains a challenge for almost all of them. In order to substantively move towards a low-carbon future, sustainable energy and climate change programmes need to be mainstreamed into municipal planning processes and institutionalised in their bureaucratic structures. City officials, and in particular those taking a lead in championing climate change, talk about the need for political buy-in at the local level, whereby municipal managers and mayoral committees actively support the work being undertaken. Having a climate change response as a standard item on the mayoral committee agenda, for instance, as is the case for some

of the municipalities listed, or having an energy and climate change strategy approved and adopted by the municipality, is key to mainstreaming climate response work into municipal planning and operations. The work is also strengthened by the existence of a specific energy or climate change department or unit, as is the case in metros of eThekwini, Cape Town and Johannesburg.

The city descriptions above show that where there is some or good institutional and governance support, more work is taking place. For instance, eThekwini and the City of Cape Town are good examples of successfully developing energy and climate departments as well as putting the issue on the municipal planning agenda. In both cases, strategies have been adopted at the mayoral committee level, which in turn helps in allocating budgets for energy and climate change implementation.

Further, the processes in place, such as regulations and procurement rules, do not always support transformation. In South Africa, municipalities cannot generate their own electricity without a national ministerial determination. This is not a straightforward process. It is clear from the energy modelling that a change in the regulations is required in order to move towards a lower carbon emissions profile.

The issues do not fit neatly within one municipal department which requires some bold decision making, partnering with civil society and business engagement. It is not a one-size-fits-all situation: the work is dynamic and challenging and in part the problem lies in the cross-cutting nature of energy and climate change as noted above.



4.1.3 FINANCE

Implementation and taking innovation to scale is affected by the way in which municipalities are funded and how they generate income. Municipalities are expected to function in a developmental manner, ensuring the delivery of basic services to their communities and growing their economies and overall development of their areas of jurisdiction. To this end they do not provide one service but many services at the same time with limited resources. All municipalities receive grants from national government to support their core mandate of service delivery and in addition they are expected to generate revenue from the sale of services such as electricity. They tend to be run on neo-liberal lines, given the need to balance their accounts. This puts pressure on how innovative and sustainable projects are rolled out. Larger metros are able to cross-subsidise services to the poor, but this is not the same for smaller and less wellresourced municipalities.

Municipalities receive funds from the public sector through intergovernmental transfers. Some of these grants are conditional and some are transferred directly to municipalities, whilst others are allocated to another entity to spend on their behalf. Many of the grants are formulabased and, in reality, are allocated to predominantly infrastructure needs, covering the financing of 60%-80% of municipal infrastructure needs. Many of the grants are poorly coordinated and not aligned with each other, and most grants are aimed at servicing the poor. Thus, for a municipality to fund renewable and energy-efficiency projects through their Municipal Infrastructure Grant they have to ensure it is targeted at the needs of the poor.

4.1.4 CAPACITY

Almost all municipalities are under resourced from a human capacity perspective. There is a great need to simplify climate language and for municipal officials and champions to engage in peer to peer learning and build their own capacity. This is clearly a critical aspect in terms of building a low carbon future. Driving transformation or doing things differently involves courage and drive but information is critical – so that the champions or people doing the work know why it is important and know that they are making a difference and feel supported. Many municipal officials are burdened by their service delivery mandates and do not have the capacity to work on climate change and sustainable energy projects. The two are one and the same and need to be seen in this light. Capacity building was another element highlighted in the DEA 2016 survey. Further the communities that the municipalities serve need to understand environmental and energy sustainability are part and parcel to development and growing the country in a way that supports future generations. Therefore engagement with citizenry is equally important.

PHOTOGRAPH BY BABLU VIRINDER-SINGH FROM THE PHOTO ARCHIVES OF SUSTAINABLE ENERGY AFRICA For a municipality to fund renewable and energy-efficiency projects through their Municipal Infrastructure Grant they have to ensure it is **targeted at the needs of the poor**.

There is a substantial gap between the services municipalities provide and the funding stream available to them. They also receive funds from the private sector in terms of donor funds and loans but these also have conditions and most funders want bankable projects.

What is emerging are growing demands and mandates in relation to sustainable energy and climate change without the necessary policy and funding changes. How local governments access climate finance or produce bankable projects poses another challenge. Many municipalities fear not complying with municipal financing mechanisms. This has an impact on implementation. On the other hand, the work is happening and sometimes a push from the ground affects the rules from national policies. It is evident from energy-related developments occurring over time within the cities, there is clearly much promising work being undertaken that is slowly shifting the local energy and carbon emissions profile (SEA, 2015, SEA 2017). It is also clear that in many case, particular for metros, that there is a sizeable move beyond pilot implementation toward the mainstreaming more sustainable practices. The SEA 2015 State of Energy report looked at comparisons over time for 7 of the 8 metros. It showed that overall energy consumption had grown, a finding that is consistent with population and electrification growth. However, growth in electricity sales and consumption decreased whilst liquid fuel consumption increased. This resulted in a decrease of carbon emissions and energy intensity over time.

If the country aims to move towards a low carbon future, then it is imperative that energy and other resourceuse patterns need to be addressed.

Current trends in two metros (Cape Town and Durban) indicate a substantial change in urban electricity sales, with sales either stabilising or decreasing since the rolling blackouts of 2008. Indications are that this decrease is most likely due to rapidly-escalating electricity prices but will also be impacted by the implementation of energy efficiency, behaviour change or fuel switching, in particular in the residential sector (SEA, 2015). In contrast, transport fuel use has escalated rapidly. If the country aims to move towards a low carbon future, then it is imperative that energy and other resource-use patterns need to be addressed - how energy is used and for who become important questions to answer. Given the predicted urban growth an opportunity exists to develop cities according to sustainable planning and development principles which will reduce carbon emissions.

Modelling undertaken by SEA shows that if cities implement aggressive energy efficiency in the built environment and in the transport sector and include local generation and the roll out of small scale embedded generation then they can substantially reduce emissions by 38% by 2050 (SEA, 2015a).

It is evident that cities potentially hold substantial influence and opportunity to transform the energy profile of the country. The national trajectory cannot be altered without transforming South Africa's cities. Although there are many promising initiatives underway towards a sustainable low-carbon development path, significant systemic changes within all three spheres of government need to occur to enable the country to achieve its energyrelated welfare, carbon and economic sustainability objectives. This is largely due to a lack of alignment across and within the spheres of government.

Municipalities are directed by policies, laws, regulations and their constitutional mandate which was established to facilitate their developmental role. Municipal mandates and functions include energy management, electricity and gas reticulation, air quality control, building plan approvals, spatial and transport planning and street lighting. Municipalities in effect have a greater influence than is often acknowledged. However, their ability to serve the communities in their area of jurisdiction can be hampered by the lack of co-operation and alignment between their policies and regulations and those of national and provincial government. This is further exacerbated by the fact that energy and climate change activities are cross-cutting in that they are located a across a spectrum of municipal functions and departments making alignment of these strategies critical.

If cities **implement** aggressive energy efficiency in the built environment and in the transport sector and include local generation and the roll out of small scale embedded generation then they can substantially reduce emissions by 38% by 2050. SEA, 2015

5. CONCLUSION

It is clear that there is an enormous amount of work happening at the municipal level in terms of addressing energy access and energy poverty, innovation around energy efficiency and renewable energy options and at the same time addressing economic development.

The challenges in terms of taking this to scale revolve around institutionalisation, governance and finances generally. Municipalities are generally capacity and resource constrained and require support to meet the new sustainable energy challenges they face, including capacity building, technical support and information development, as well as assistance with the new institutional and regulatory requirements in relation to this growing field of work.

To this end new, sustainable approaches to urban development are vital. The past decade has seen a flourishing of sustainable energy approaches in city development and their manifestation in visions, strategies and plans. There has been a sizeable shift towards translating the visions and ideals into practical actions. Pioneering work undertaken within a number of South African cities is underway with exploring the fundamentals underpinning how we work - economically and developmentally. Cross-sectoral partnerships involving strong engagement with citizens and the private sector form among the important elements of a new way of operating. Ultimately vison, strong leadership and political support are required for the way forward.





PHOTOGRAPH BY MARK LEWIS FROM THE PHOTO ARCHIVES OF SUSTAINABLE ENERGY AFRICA

6. REFERENCES

Biermann, S & Van Ryneveld, M, 2007. Improving the location of low-income housing delivery in South African urban areas. *10th International Conference on Computers in Urban Planning and Urban Management (CUPUM)*, 11-13 July 2007. Iguassu Falls, Parana, Brazil.

Caprotti, F, 2018. Future cities: moving from technical to human needs. Forthcoming in *Palgrave Communications*.

CDIAC [United States Department of Energy's Carbon Dioxide Information Analysis Centre], 2012. List of countries by 2010 emission estimates. Available at - http://cdiac.ornl.gov/trends/emis/perlim_2009_2010_estimates.html

DCOG [Department of Cooperative Governance], 2013. *Towards An Integrated Urban Development Framework* - *A Discussion Document*. Available at: http://www.cogta.gov.za/index.php/documents/doc_view/1036-discussion-document-for-integrated-urban-development-framework.raw?tmpl=component [Accessed November 2017].

DEA [Department of Environmental Affairs], 2015. South Africa's Intended Nationally Determined Contribution (INDC). Discussion Document. Pretoria, South Africa. Available at: https://www.environment.gov.za/sites/default/files/docs/ sanational_determinedcontribution.pdf [Accessed November 2017].

DEA [Department of Environmental Affairs], 2016. 2016 Local Government Climate Change Mitigation Assessment Report. Pretoria, South Africa.

DEA [Department of Environmental Affairs], 2014. South Africa's Greenhouse Gas Emission Mitigation Potential Analysis Report. Pretoria, South Africa.

DEA [Department of Environmental Affairs], 2007. Long-Term Mitigation Scenarios – Strategic Options For South Africa. Pretoria, South Africa.

DEA [Department of Environmental Affairs], 2011. The National Climate Change Response White Paper. Pretoria, South Africa.

DME [Department of Minerals and Energy]. 2005. Energy Efficiency Strategy Of The Republic Of South Africa. Pretoria, South Africa.

DoE [Department of Energy], 2012. A Survey Of Energy-Related Behaviour And Perceptions In South Africa, The Residential Sector. Available at: http://www.energy.gov.za/files/media/Pub/Survey%20of%20Energy%20 related%20behaviour%20and%20perception%20in%20SA%20-%20Residential%20Sector%20-%202012.pdf [Accessed October 2017].

Ewing, K & Mammon, N, 2010. Cape Town Den[city]: towards sustainable urban form. In Swilling (M.) Ed 2010. Sustaining Cape Town, Imagining A Liveable City. Stellenbosch, Cape Town. South Africa.

Eberhard A, 2011. *The Future Of South African Coal: Market, Investment And Policy Challenges.* Working Paper #100. Program of Energy and Sustainable Development. Freeman Spogli Institute for International Studies, Stanford University, USA.

Fine B, & Rustomjee, Z, 1997. South Africa's Political Economy: From Minerals-Energy Complex To Industrialisation. Wits University Press, Johannesburg, South Africa.

FFC [Financial and Fiscal Commission], 2011. The Economic And Fiscal Costs Of Inefficient Land-Use Patterns In South Africa. Palmer Development Group, African Centre of Cities and Stephen Berrisford Consulting, South Africa.

HDA [Housing Development Agency], 2012. South Africa: Informal Settlement Status. Housing Development Agency, Johannesburg, South Africa.

NPC [National Planning Commission - The Presidency Republic of South Africa], 2012. *National Development Plan – Vision for 2030.* Pretoria, South Africa.

NPC [National Planning Commission - The Presidency Republic of South Africa], 2011. *Diagnostic Overview*. Pretoria, South Africa.

Polokwane Municipality, 2016. *State of Energy Report for Polokwane.* Report produced by Sustainable Energy Africa for Polokwane Municipality, South Africa.

SACN [South African Cities Network], 2012. Secondary Cities In South Africa: The Start Of A Conversation. Background Report. South African Cities Network, Johannesburg, South Africa.

SACN [South African Cities Network], 2011. Towards Resilient Cities: A Reflection On The First Decade Of A Democratic And Transformed Local Government In South Africa 2001-2011. South African Cities Network, Johannesburg, South Africa.

SEA [Sustainable Energy Africa], 2015. State Of Energy In South Africa's Cities. Cape Town, South Africa.

SEA [Sustainable Energy Africa], 2015a. Citywide Mitigation Potential For South Africa. Cape Town, South Africa.

Reddy, Y & Wolpe, P, 2014. Tackling Urban Energy Poverty In South Africa. SEA, Cape Town, South Africa.

SEA [Sustainable Energy Africa], 2006. *State Of Energy In South Africa's Cities – Setting A Baseline.* SEA, Cape Town, South Africa.

SEA [Sustainable Energy Africa] & GIZ, 2015. *Review Of Best Practice Solar Water Heating Implementation By Local Government.* A report produced by SEA for GIZ, South Africa.

Stats SA [Statistics South Africa], 2011. South African Census 2011. Pretoria, South Africa.

Turok, I, & Borel-Saladin, J, 2013. The spatial economy. Background Research Report for the Integrated Urban Development Framework Draft. Human Sciences Research Council, South Africa.

WCG [Western Cape Government], 2017. Western Cape Growth Potential Study, 2017. South Africa.

7. APPENDIX ONE: PROFILE OF CITY ENERGY INNOVATIONS

	MUNICIPAL CATEGORY (As per the National Department of Environmental Affairs)	STRATEGIES	TRANSPORT	CHAMPION	ENERGY POVERTY
Cape Town Metropolitan Municipality	READY	YES • State of Energy Reports • Mayoral endorsement • Green bond • Energy and Climate Action Plan	YES • My Citi Programme	YES	YES • Low income energy services strategy • Ceiling retrofit • Informal electrification
EThekwini Metropolitan Municipality	READY	YES • Energy office • Streamlining climate change into each service delivery department	YES	YES	YES
George Local Municipality	NOT APPLICABLE	NO • IDP sustainable vision	YES • Go George Initiative	YES	YES • Free Basic Electricity Subsidy rollout • Alternative energy rollout – Hotbox
City of Johannesburg Metropolitan Municipality	READY	YES • Mayoral endorsement • Green bond	YES • Rhea vaya • Gautrain • Corridors of freedom	YES	YES • Solar Water Heater rollout • Free Basic Electricity Subsidy • Alternative Energy technology roll-out
Nelson Mandela Bay Metropolitan Municipality	READY IN TWO YEARS		YES		
Polokwane Municipality	READY IN TWO YEARS	YES • State of Energy Report • Energy strategy	YES	YES	YES • Solar lights • Hotbox
City of Tshwane Metropolitan Municipality	READY	YES • State of Energy Reports • Sustainable Unit in mayor office • Green economy transition	YES • Integrated transport plans and • Sustainable Development Plan	NO	YES

EFFICIENCY	RENEWABLE ENERGY ELECTRICITY GENERATION	SMALL SCALE EMBEDDED GENERATION	URBAN LIVELIHOODS
YES • Own buildings and Energy efficiency Demand-Side Measures Programme (EEDSM) • Energy Efficiency forum	Taking minister to court	YES	YES
YES • EEDSM measures • Solar water heaters • Energy efficient traffic lights	YES • Rooftop PV rollout	YES	YES
YES	NO	NO	YES
YES • Own buildings • EEDSM measures		YES	YES
		SSEG	
YES • Municipal retrofit • Traffic lights	YES	YES	YES
YES • Solar water heate		YES • Developing SSEG guidelines and municipal tariffs	

8. APPENDIX TWO: CITY ENERGY PROFILE

CAPE TOWN





ETHEKWINI

ENERGY BY SOURCE IN ETHEKWINI 2011







EMISSIONS BY SECTOR IN CAPE TOWN 2011



EMISSIONS BY SOURCE IN ETHEKWINI 2011





ENERGY BY SECTOR IN ETHEKWINI 2011

EMISSIONS BY SECTOR IN ETHEKWINI 2011



JOHANNESBURG



ENERGY BY SECTOR IN GEORGE 2011 Government

> Residential 24%

Industrial 24%

Residential

36%

Commercial

7%

Commercial

_5%

3%

Transport 44%

ENERGY BY SOURCE IN JOHANNESBURG 2011



EMISSIONS BY SOURCE IN GEORGE 2011



EMISSIONS BY SECTOR IN GEORGE 2011

Government

5%

Transport

16%

Industrial

36%



EMISSIONS BY SOURCE IN JOHANNESBURG 2011





ENERGY BY SECTOR IN JOHANNESBURG 2011

EMISSIONS BY SECTOR IN JOHANNESBURG 2011



NELSON MANDELA BAY

POLOKWANE





ENERGY BY SECTOR IN POLOKWANE 2011

EMISSIONS BY SECTOR IN POLOKWANE 2011



5 METROS



ENERGY BY SOURCE IN TSHWANE 2011

Government Agriculture 2% 1% Residential 15% Commercial 5% Industrial 23%

ENERGY BY SECTOR IN TSHWANE 2011



ENERGY BY SOURCE:

AVERAGE OF 5 METROS 2011

EMISSIONS BY SOURCE IN TSHWANE 2011



EMISSIONS BY SOURCE: AVERAGE OF 5 METROS 2011











EMISSIONS BY SECTOR: AVERAGE OF 5 METROS 2011



5 NON-INDUSTRIAL SECONDARY CITIES

2 INDUSTRIAL SECONDARY CITIES





ENERGY BY SECTOR: AVERAGE OF 5

NON-INDUSTRIAL SECONDARY CITIES 2011



EMISSIONS BY SOURCE: AVERAGE OF 5 NON-INDUSTRIAL SECONDARY CITIES 2011



EMISSIONS BY SECTOR: AVERAGE OF 5 NON-INDUSTRIAL SECONDARY CITIES 2011



EMISSIONS BY SOURCE: AVERAGE OF 2 INDUSTRIAL SECONDARY CITIES 2011





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