The contribution of low-carbon cities to South Africa's greenhouse gas emissions reduction goals

Briefing on urban energy use and greenhouse gas emissions

SUSTAINABLE ENERGY AFRICA

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This briefing paper draws on extensive work undertaken by Sustainable Energy Africa (SEA) with South African local governments (municipalities) over the past 16 years, and in particular recent research undertaken by SEA including the State of Energy in South African Cities 2015 Report, Cape Town's State of Energy and LEAP (Long Range Energy Alternative Planning) based technical reports and Tackling Urban Energy Poverty in South Africa Report 2014.

EXECUTIVE SUMMARY

South Africa is ranked among the world's top 12 largest carbon dioxide (CO_2) emitters, largely due to dependence on plentiful coal for electricity generation and an energy-intensive industrial and mining sector. In South Africa, GHG emissions totalled 579 million tonnes CO_2e in 2010 (DEA, 2013). Under the Copenhagen Accord, South Africa committed to cut emissions by 34% from business as usual (BAU) by 2020, and by 42% by 2025. These targets represented a relative, not absolute, decline in emissions and are conditional on international support. They follow a "peak, plateau, decline" (PPD) trajectory, where GHG emissions should peak by 2020, plateau until 2030 and begin to decline after 2030.

South Africa's recently released "intended nationally determined contribution" (INDC) builds on those targets by moving from a relative deviation from BAU to an absolute PPD. It sets national GHG emission reduction targets of 212–428 Mt CO_2e by 2050, and 398–614 Mt CO_2e between 2025 and 2030 (DEA, 2015). The INDC is framed by the National Development Plan 2030 (NDP, 2012) and National Climate Change Response White Paper (DEA, 2011). South Africa identifies several policy mechanisms to achieve the reductions: a carbon tax, sectoral emission reduction targets, and company-level carbon budgets. South Africa's INDC also indicates the need for increased institutional and human capacity, as well as significant climate finance to achieve these goals. It further identifies the developmental needs of the country to meet these targets, as well as the need to adapt to the growing impacts of climate change.

South Africa faces many challenges: the economy is largely energy inefficient and resource-intensive, human development indices remain low, and inequality and unemployment are high. Energy- and other resource use patterns need to be addressed in order to move towards a sustainable, low-carbon and equitable country in a resource-constrained future. This is a substantial task for a country with an economy dependent on coal for 93% of its electricity generation, an energy-intensive industrial sector and an energy sector responsible for 82% of total GHG emissions (DEA 2013). Adding to the challenge is the need to address energy poverty, which manifests in the lack of access to affordable, adequate, reliable, safe and environmentally benign energy services (UNDP, 2000, SE4ALL, 2013).

South Africa continues to experience rapid urbanization, with about 65% of its population in urban areas. Cities play a fundamental role in terms of population, economic growth, energy and other resource consumption patterns. If planned and governed well, cities can contribute to employment, poverty alleviation, and a better life for citizens, and offer the potential to transform the emissions profile of country. Many of the functions of a municipality relate to demand-side energy management, including electricity distribution, building plan approvals, and spatial and transport planning. While reducing emissions associated with power production is largely outside of the direct control of cities, city governments do have the opportunity to leverage their influence over national- and regional-level energy supply decisions.

This paper aims to identify opportunities for urban emissions reduction in South Africa.[1] The key findings illustrate cities' important role in reducing emissions in South Africa, including:

1. **Cities are key influencers of energy use**: The 18 major metropolitan areas and secondary cities in South Africa consume about 37% of the country's energy, making them key drivers of change and players in South Africa's economy. They account for 46% of national electricity consumption, 52% of the country's petrol and diesel consumption, and 32% of country's energy-related GHG emissions, and produce about 70% of the country's economic wealth. This is substantial given that 46% of

[1] This analysis builds on results from the author's prior publication, *State of Energy in South African Cities Report 2015*, published by Sustainable Energy Africa.

the total population live in these 18 urban areas, which together occupy only 4.6% of land space.

2. **Energy consumption per capita is decreasing at the same time as the economy is growing:** Over a 10-year period, South Africa's metro areas have experienced positive shifts in their energy and emissions profiles. While energy consumption has increased in absolute terms (which is expected for a developing country and is linked to population and economic growth), per-capita electricity consumption has been decreasing since 2007. This trend reflects a slight decoupling of economic growth from energy consumption which is very significant in a developing context.

3. **City actions are likely making an impact:** Although it is not possible to state conclusively that these changes are due to abatement measures undertaken by municipal policy-makers, it is clear that the mitigation measures to expand renewable energy, improve energy access and promote energy efficiency currently underway in urban areas are reducing emissions. A summary of those measures is listed below:

    - **Renewable energy:** Substantial renewable energy development is under way in South African municipalities, including landfill gas, sewage methane and micro-hydro on water distribution systems, solar PV rooftop generation.
    - **Energy access:** Municipalities throughout the country are working to alleviate energy poverty through electrification and provision of energy subsidies to the poor.
    - **Energy efficiency:** Municipalities are promoting energy efficiency measures in the commercial and residential sectors and in their own operations through street lighting, traffic lighting, and building energy efficiency retrofits.

4. **Despite recent efforts, emission reductions from transport sector are limited:** The transport sector is the dominant energy- consuming sector in most cities across the country. In spite of several important public transport interventions, urban transport is still characterized by inefficient, congested roads and a dependence on private vehicles. While a few urban areas have progressive spatial planning frameworks, the urban form has not changed significantly.

5. **National government action is needed to enable urban abatement:** There is a substantial opportunity for emissions and energy reduction to be achieved at the city level in South Africa. Many cities have already implemented key strategies, but these need to be implemented to scale with greater vertical alignment and support from national government. To ensure implementation and enable and facilitate the mitigation potential that cities can provide, the South African national government must address the following:

    - **Explore alternatives to the current energy market:** Review current structure that requires cities to purchase bulk electricity from a single source (Eskom, South Africa's single electricity generating utility)
    - **Enable city development of renewable energy sources:** NERSA (South Africa's energy regulating body) could adjust regulations to allow local government to generate electricity.
    - **Facilitate greater coordination and support from national government agencies:** Policy alignment across government agencies and levels of government is needed to enable innovative decision-making and financing of mitigation actions.

6. **Mitigation measures must help accelerate integration and access to social and economic resources:** To realize the full potential from urban action, the next step will be to move the work and approaches from a slightly marginal concept of

emissions reduction to the heart of the city's planning engine: squarely promoting an urban infrastructure, economy and form that accelerates integration and access to social and economic resources while ensuring sustainability and developing a low-carbon economy. This may entail shifts between the spheres of government whereby national government enables local government to assume additional powers relating to electricity generation and their revenue models. It requires strong partnerships between business, civil society and all three spheres of government. It requires awareness and consciousness of what needs to shift. It requires getting practical and supporting that practice with the right policies, the right regulations and the right skills and capacity development. All of this is critical to the success of meeting South Africa's climate response objectives and targets.

ACRONYMS

APM	All Possible Measures
APMF	All Possible Measure with Fuel Switching
AR5	Intergovernmental Panel on Climate Change *Fifth Assessment Report*
BAU	Business as Usual
BRICS	Brazil, Russia, India, China and South Africa
CO_2	Carbon dioxide
CO_2e	Carbon dioxide equivalent
DEA	Department of Environmental Affairs
DERO	Desired Emission Reduction Outcome
DOE	Department of Energy
EEDSM	Energy Efficiency Demand Side Management
GDP	Gross Domestic Product
Gg	Gigagramme
GHG	Greenhouse Gas
Gt	Gigatonne
GVA	Gross Value Added
INDC	Intended Nationally Determined Contribution
IPCC	Intergovernmental Panel on Climate Change
IRP	Integrated Resource Plan
KPA	Key Performance Area
LTMS	Long term Mitigation Scenarios
Mt	Megatonne
NCCRWP	National Climate Change Response White Paper
NDP	National Development Plan
NERSA	National Energy Regulator of South Africa
NGO	Non-governmental organization
PPD	Peak, Plateau, Decline
PV	Photovoltaic
RDP	Reconstruction and Development Programme
REIPPPP	Renewable Energy Independent Power Producer Procurement Programme
SSEG	Small Scale Embedded Generation
SWH	Solar water heater
UNFCCC	United Nations Framework Convention on Climate Change

1. CITIES AND GREENHOUSE GAS EMISSIONS IN SOUTH AFRICA

Cities have a key role in changing the global GHG emissions profile

Cities have become major centres of population growth, trade and labour markets, and around the world, people are rapidly moving from rural areas to the cities. It is expected that the global population will grow to 9 billion by 2050, and that most of this growth will occur in cities (UN DESA, 2015). Africa has the highest population growth rate in the world, and is expected to account for more than half of the world's population growth between 2015 and 2050. It is well documented that cities consume the bulk of the world's resources, even though they occupy a small share of the land. It is estimated that urban areas globally cover about 3% of land mass and are home to more than 53% of the population, expected to rise to 66% by 2050.

The Intergovernmental Panel on Climate Change *Fifth Assessment Report* (AR5) draws links between climate change and development, finding that economic and population growth are key factors contributing to the increase carbon dioxide (CO_2) emissions (IPCC, 2014). The report also identifies cities as major players in reducing global GHG emissions. This presents a significant shift in perspective and highlights the key role cities have in changing the global GHG emissions profile. Cities therefore need to be well placed to respond proactively to the impact of climate change, which implies moving towards a low carbon development path.

South Africa's priorities for urban, social and economic development

South Africa continues to experience rapid urbanization. About 65% of the country's 52 million people live in urban areas, of which 40% are in metropolitan municipalities. Since 1994, South Africa has witnessed a wave of migration from the countryside to the cities as residents search for better employment opportunities. Urban populations in South Africa are forecasted to reach 71% by 2030 and 77% by 2050 (UN DESA, 2015).

South African cities have historically developed along sprawling, low-density suburban lines, resulting in substantial transport inefficiencies. This urban form is rooted in Apartheid's inequitable and segregated spatial-land distribution policies, but is also a consequence of modernist planning, which emphasises suburban development and separation of work and leisure (Biermann & Van Rhyneveld, 2007; Ewing & Mammon, 2010; FFC, 2011; SACN, 2011). Factors such as sprawling and severely polarised cities not only impose significant costs but also limit the ability of poor households to benefit from the economic opportunities and public services that cities offer. The result is that South African cities are also centres of abject poverty, leaving large numbers of the urban populace without adequate access to basic services such as modern forms of energy, or even the ability to afford a constant supply of this energy.

Since democracy in 1994, South African policy development has focussed on the huge challenge of redressing the injustices of Apartheid. In many respects, addressing issues of climate change and the environment in 1994 were low on the government's agenda. Yet, well-considered urban development planning has the ability to resolve some of these challenges in terms of boosting economic activity, lowering the environmental consequences of sprawl and overcoming the historical spatial distortions that marginalize poor communities.

The country's overarching development objectives were encapsulated in the Reconstruction and Development Programme (RDP) White Paper[2] of 1994, which promoted development through the expansion of infrastructure in poor communities with a central focus on the delivery of basic services (The Presidency, 1994). It was seen as a means of transforming the country

[2] Reconstruction and Development Programme was the overarching ANC socio-economic policy framework introduced in 1994

from a segregated to a democratic state, based on the premise of social and economic advancement in an equitable manner and a central focus on the development of infrastructure. This led to an impressive national housing and electrification programme aimed at achieving universal access[3] by 2014, which was recently extended to 2025. The bulk of the electrification programme has taken place in urban centres, predominantly within the formal housing sector and has been slow to include a fast-growing informal and backyard dweller sector typical of urban settlements (DoE, 2012).

It is well documented that urbanisation can contribute towards economic growth largely because the concentration of people in itself promotes economic opportunity. However, in South Africa, the economic benefits of urbanization have not yet been fully realized (Turok & Borel-Saladin, 2013). This is partly explained by the urban spatial form, rural-urban migration and a shortage of land for development.

GHG emissions in South Africa are dominated by the industrial sector

Over the past 100 years, South Africa's economy has been built around a mineral-energy complex that continues to dwarf all other areas of economic activity (Fine & Rustomjee, 1997). South Africa is rich in cheap coal and a range of minerals, which form the bedrock of the country's economic advantage. The power sector, reliant on cheap coal, has in turn been built to support further mining of minerals, notably gold and platinum and associated smelting production. Much of the country's manufacturing and service activity is horizontally linked to the mining sector, so that the contribution of these sectors to national wealth (GDP) can often not be decoupled from the primary economic activity of mining.

As a result, South Africa's economy is extremely energy intensive (energy used per unit of economic production) even by global standards. Such energy intensity is generally associated with growth, employment, and high human development indices. Despite South Africa's consistent economic growth since 1994, this has not been accompanied by increases in per capita GDP across the country and the country continues to face fundamental development challenges (Leibbrandt et al, 2010; NPC, 2011). Growth has not produced the level of expected change and social development.

In South Africa, 45% of energy generated is consumed by industry, 20% by transport and 10% by the residential sector – the latter occurring mostly in the urban areas and by mid- to high-income households (Winkler, 2008). South Africa is ranked among the world's top 12 largest carbon dioxide (CO_2) emitters, largely due to heavy dependence on coal for 93% of electricity generation (DEA, 2013; CDIAC, 2012; Eberhard, 2011; DME, 2005).

South Africa's commitment to climate action to date

South Africa became a signatory to the United Nations Convention on Climate Change (UNFCCC) in 1993 and ratified it in 1997. In December 2009, President Zuma announced South Africa's commitment (under the Copenhagen Accord) to reduce emissions by 34% from Business As Usual (BAU) by 2020 and by 42% by 2025. This commitment is conditional on a fair, ambitious and effective agreement in the international climate change negotiations and

[3] Access is understood to be the provision of modern energy forms, such as electricity and a range of renewable energy sources. It does, moreover, exclude energy sources harmful to health and environment, such as paraffin, candles and firewood. Access to electricity is determined by two key factors: 1) the number of households connected to electricity, either through the national grid or alternative sources such as solar panels and 2) the affordability of that electricity – poor households need to be able to afford electricity to benefit from its use.

international support (South Africa Climate Tracker, 2015). These targets represent a relative (against BAU), not absolute, decline in emissions.

South Africa's commitment under the Copenhagen Accord was in line with the nationally developed Long Term Mitigation Scenarios (LTMS) that outline three scenarios: (i) growth without constraints, (ii) business as usual or current development paths, and (iii) '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 LTMS was endorsed by the South African government in 2008, and a Peak, Plateau, Decline (PPD) carbon trajectory was adopted as the country's strategic direction. Under PPD, GHG emissions are expected to peak by 2020, plateau until 2030 and begin to decline after 2030 as a result of a suite of measures in place, notably extensive implementation of energy efficiency interventions, the introduction of a carbon tax and increased electricity production by nuclear and renewable energy (DEA, 2011).

In 2015 South Africa's position shifted from a 'relative' deviation from BAU to an absolute PPD in its emissions trajectory range. This position is stated in South Africa's 2015 INDC and is indicative of an important policy shift. It was informed by the national GHG mitigation potential analysis study, which was adopted by the South African government in July 2014. The study outlines potential low-carbon pathways and their impact on the country's emissions profile between 2010 and 2050. It includes the many energy intensive industries present in South Africa, such as –the coal to liquid fuel industry, iron smelters, and mining. The study provided an updated assessment of the mitigation options in the national Long Term Mitigation Scenarios and was able to include importantly the wider socio-economic and environmental impacts of the mitigation options available.
According to the recent National GHG Inventory, emissions in South Africa totalled 579 million tCO2e in 2010, an increase of nearly 25% since 2000 (DEA, 2013). The study highlighted a continuous increase in emissions from the energy sector over the past 10 years. Despite challenges acknowledged in developing a national GHG inventory, sufficient information is now available to inform implementation strategies.

National-level climate mitigation policies in South Africa

Many of the country's national policies and strategies already address issues of climate change. The country's first National Development Plan (NDP) 2030, released in 2012, provides an overarching plan for the country, advocates the need to grow the economy, create jobs, and substantially reduce inequality and poverty. Importantly, it promotes achieving the 'Peak, Plateau and Decline trajectory' of GHG emissions and the concurrent need for a move to a less carbon intensive electricity sector as critical to this endeavour. It further highlights the need to transform our human settlements to have strong and efficient spatial planning systems in place and to densify our cities. The NDP is now a key plan for the country and is to underpin all policies and frameworks going forward as noted above.

The National Climate Change Response White Paper (NCCRWP) of 2011, presents the country's vision for an effective climate change response and the long-term transition to a climate-resilient low-carbon economy and society. The document identifies energy efficiency measures, demand-side management and moving to a less emissions-intensive electricity generation mix as the main intervention opportunities for mitigation, along with the introduction of a carbon tax and carbon budget. It emphasizes the importance of alignment of policies across national departments to achieve this, specifically calling out a role for local governments in implementation.

South Africa's INDC discussion document (2015) states the need to both consider the developmental needs of the country as well as deal with climate change imperatives; in other words, actions taken must be mindful of the need for a just transition leading to "zero poverty". The current South African goal is to maintain temperatures below 2°C above pre-industrial levels, but in light of recent research indicating that a global 2°C rise in temperature translates to 4°C rise for South Africa by the end of the century (DEA, 2015), South Africa's INDC instead suggests that the goal needs to be reduced to 1.5°C., in hopes of avoiding more extreme impacts in South Africa.

In particular, the national intention is to achieve national GHG emission reduction targets of 212–428 Mt CO_2e by 2050, and 398–614 Mt CO_2e between 2025 and 2030 (utilizing 2016 as the starting point towards reduction). To achieve this target South Africa identifies the following mechanisms (in line with the NCCRWP): a carbon tax, Desired Emission Reduction Outcomes (DERO) for sectors, and company-level carbon budgets. The INDC indicates that this can only be achieved through increased institutional and human capacity as well as huge investments in order to achieve this goal.

Urban energy consumption and GHG emissions in South Africa

The State of Energy in South African Cities 2015 Report (SEA, 2015) has shown that energy consumption over time has increased in absolute terms in South Africa's metros which is to be expected in a developing country context and is linked to population and economic growth (see Figure 1). However electricity consumption in the metros has declined since 2007, in part a response to the electricity supply crisis and high price increases, but also attributed to the introduction of sustainable energy interventions at the local level.

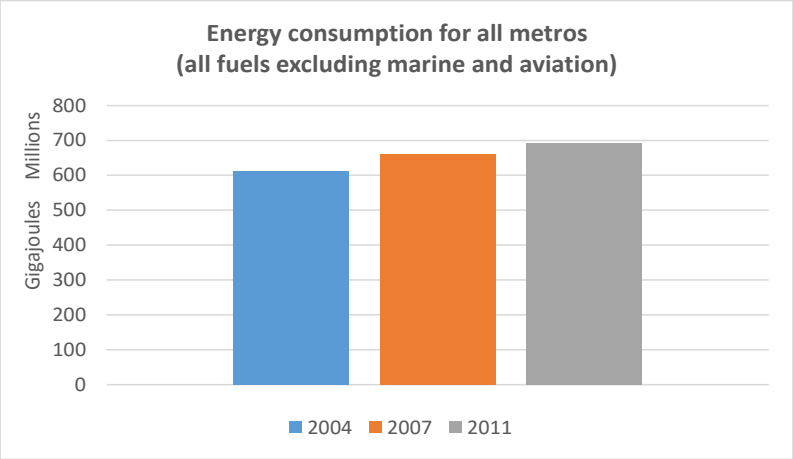

Figure 1: Energy consumption for all metros over time *(SEA, 2015)*

While the economy and population are growing in these urban centres, a decline in energy intensity[4] can be observed over time. Between 2004 and 2011, metros economies grew by an average annual rate of 4.2%, while energy consumption grew by 1.8%. This trend reflects a slight decoupling of economic growth from energy consumption which is very significant in a developing country context. If less energy is used to produce a unit of economic output, this points to resources being used more efficiently.

Carbon emissions per capita is a common global indicator of emissions levels for a country or city, providing perspective on the country's or city's progress in moving toward a low-carbon future. Overall South African metros display lower emissions per capita values than South

[4] Energy intensity is the amount of energy consumed to produce a unit of economic value.

Africa as a whole, in part because most large industries are located outside the metro boundaries.

The State of Energy in South African Cities 2015 Report (SEA, 2015)[5] provides an important overview of the energy consumption and carbon emission profiles of 18 major metropolitan and secondary cities across South Africa.[6] It tracks the pioneering work undertaken at the city level in terms of energy efficiency and renewable energy strategies, policies and projects.. The cities in this study consume approximately 37% of national energy making them key drivers of change and players in South Africa's economy. They account for 46% of national electricity consumption, 52% of the country's petrol and diesel consumption, 32% of energy related GHG emissions and produce approximately 70% of the country's economic wealth (see Figures 2-3). This is substantial given that 46% of the total population live in these 18 urban centres, which together occupy only 4.6% of the country's land area.

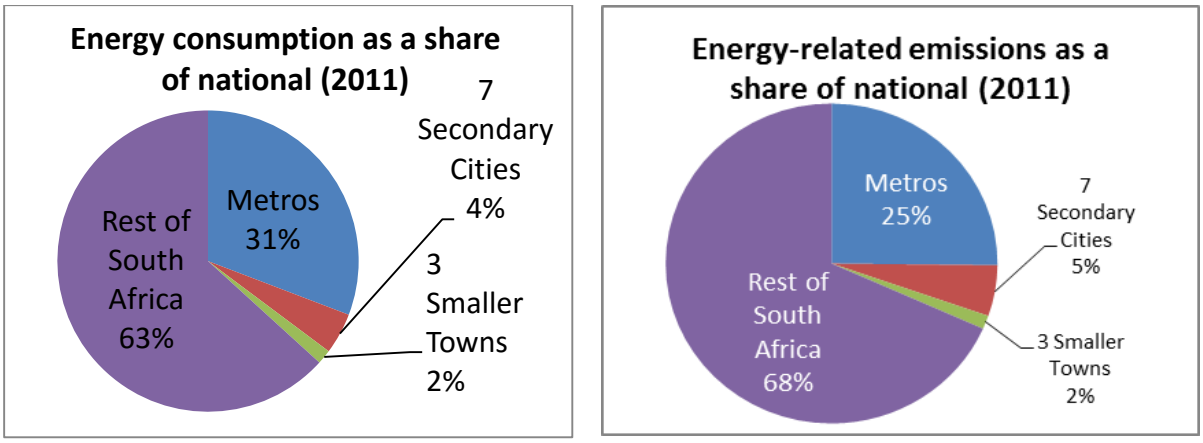

Figure 2: Energy consumption and energy related GHG emissions as a share of national

[5] The baseline data year is 2011. This is the most recent year for which there is a comprehensive national household dataset available, namely the national Census 2011, which includes reliable demographic and energy services information.

[6] The 18 municipalities were selected based on the following criteria: municipalities actively involved in the Sustainable Energy Africa (SEA) learning network and the urban energy platform with the South African Local Government Association (SALGA), the South African Cities Network (SACN) and the International Council for Local Environmental Initiatives (ICLEI); municipalities participating in key national programmes, such as the municipal energy efficiency demand side management (EEDSM) programme and the ICLEI Local Emission Development Strategies (urban LEDS) for secondary cities; municipalities that provide a representative sample of geographic, economic and social (including municipal type and size) including metros, secondary cities, industrial cities and small towns. The 18 municipalities include the eight large cities (Cape Town, Johannesburg, Ekurhuleni, Tshwane, eThekwini, Buffalo City, Mangaung, Sol Plaatje), seven secondary cities (George, Drakenstein, Steve Tshwete, Rustenburg, Polokwane, Mbombela) and three smaller towns (Saldanha Bay, KwaDukuza, King Sabata Dalindyebo).

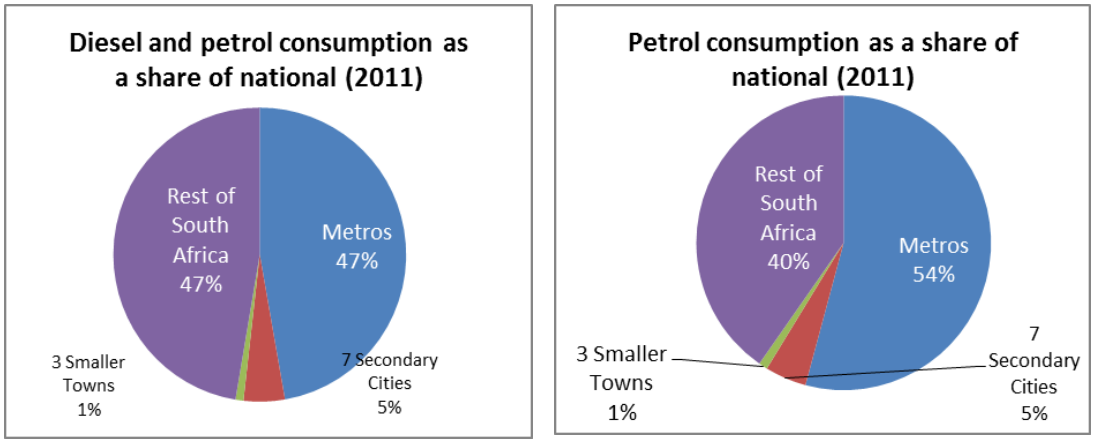

Figure 3: Petrol and diesel consumption as a share of national

The most concentrated energy consumption occurs in South Africa's eight largest metro areas, which account for nearly one-third of national energy consumption, 36% of national electricity consumption and 54% of national petrol consumption and 47% of national diesel consumption (see Figures 2 and 3). In terms of energy related GHG emissions the cities in this study account for 32% of national emissions. The eight metros produce proportionally less emissions than other municipal areas, considering their population size and economic contribution.

The major fuels consumed in metros are ***electricity*** used predominantly for lighting, heating, cooling and cooking, ***petrol and diesel*** mostly used for transport (see Figure 4). Diesel is used for freight and passenger transport, as well for industrial applications (stationary combustion, e.g. generators). Petrol is used almost exclusively for private passenger transport (with the exception of minibus taxis, which use a negligible amount).

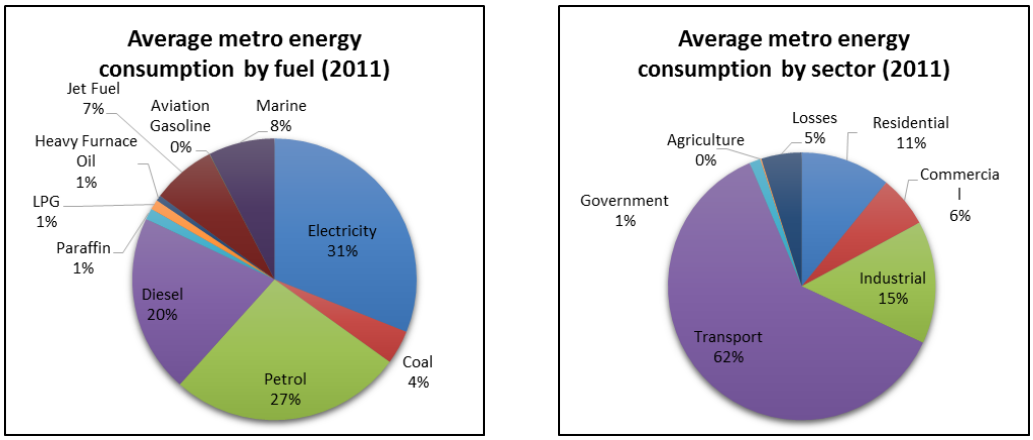

Figure 4: Average metro energy consumption by fuel type and sector

The transport sector dominates urban energy consumption

The transport sector, made up of passenger and commercial/industrial transport, dominates urban energy consumption, accounting for 60–70% of total energy consumption in metros. This is higher than smaller municipalities, because metros tend to have substantial airports and ports, a wealthier populace (greater car ownership) and more economic activity (freight). South African cities are some of the least dense cities in the world, giving rise to a heavy reliance on transport fuels to ensure mobility of residents and commercial activity. This in turn renders the city vulnerable to oil price increases and accounts for a sizeable economic cost. Urban spatial form, urban management and local transport options are critical factors in energy consumption

for transportation within large metro areas. Moreover, local combustion of transport fuels directly impact the levels of local air pollution and the "liveability" of the city.

The residential, commercial, and industrial sectors are responsible for the largest share of urban carbon emissions

The residential, commercial and industrial sectors, whose dominant energy source is electricity, account for a smaller share of energy use (Figure 4), but a larger proportion of GHG emissions than the transport sector (Figure 5). This is due to higher carbon emissions per unit of energy consumed for electricity than for liquid fuels, since electricity is generated from coal-fired power stations using low-grade coal.

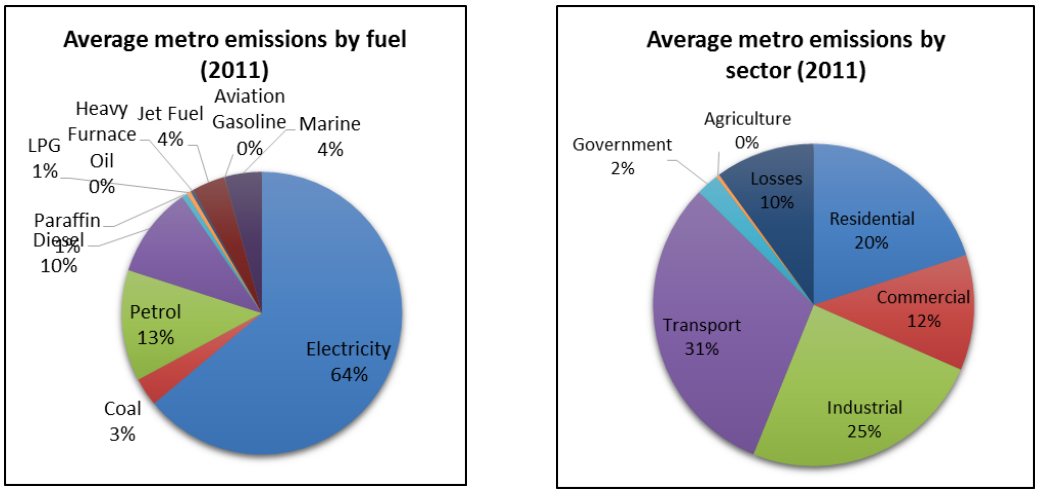

Figure 5: Average metro emissions by fuel type and sector

2. OPPORTUNITIES FOR IMPROVING URBAN ECONOMIC AND SOCIAL CONDITIONS WHILE DECREASING GHG EMISSIONS

While South Africa is a developing nation and needs be cognizant of its developmental agenda of growing the economy and reducing inequality and poverty, it also has to deal with the threat of climate change and fulfil its national and international climate response obligations. Cities are therefore key to a low carbon transformation especially as they are the seat of delivery of national policies and the sphere of government closest to the communities it serves.

At the national scale, analysis by the Department of Environmental Affairs (DEA) has indicated that the most critical GHG abatement measures between now and 2050 relate to electricity supply and the industrial sectors. These findings are not surprising given the high energy intensity of the national economy and the continued use of coal in South Africa's electricity production. (The industrial sector includes mines, smelters, and steel works, which are largely located outside the boundaries of the urban areas.) The DEA's Mitigation Potential Analysis Report (2014) finds that, assuming all abatement measures are implemented, GHG emissions are expected to decline in absolute terms between 2020 and 2030, and are thereafter projected to rise again.

At the sub-national scale, analyses have similarly underscored the importance of decarbonizing electricity (WCPG, 2015; City of Cape Town 2015a). For example, recent energy modelling undertaken for the City of Cape Town and a South African city wide mitigation potential study (SEA,2015) illustrate the high emissions profile for the residential, commercial and industrial

sectors from electricity use.[7] The analysis of both studies further indicate that the largest energy demand reductions will have to arise from the transport sector, as transport accounts for the highest proportion of energy consumed in our cities. The findings indicate that in order to drive down GHG emissions in line with the national PPD trajectory, electricity and transport efficiency need to be implemented and the electricity supply sector must be diversified to include a greater share of renewable electricity generation in the mix particularly including local (decentralized) generation (see Figure 6).

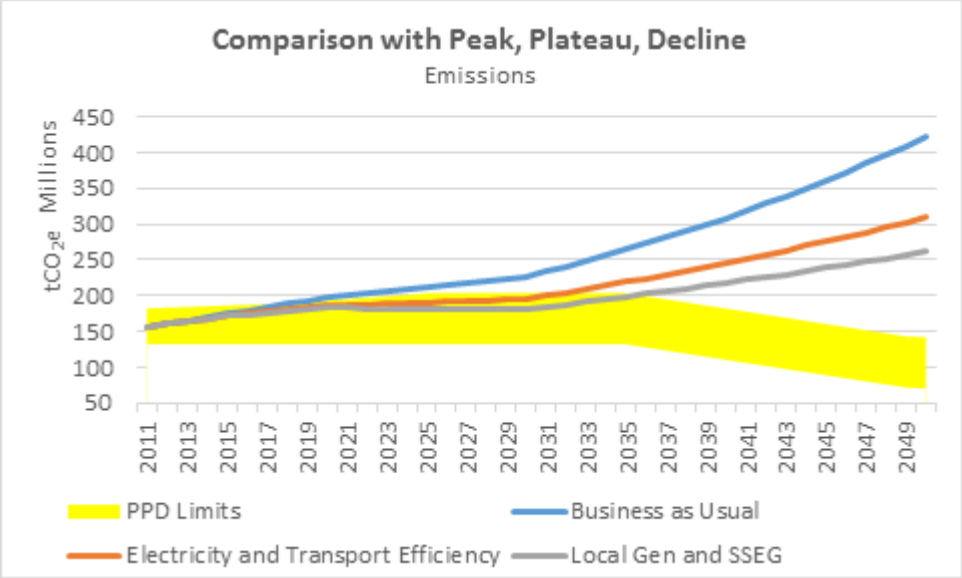

Figure 6. Citywide mitigation potential for South Africa

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 emissions trajectory of the country. This is particularly crucial when considering that the national energy and emissions profile includes the large industries notably the mining and mineral beneficiation sectors which may be less likely to transform quickly.

Cities play a fundamental role in terms of population and economic growth, energy and other resource consumption patterns. If planned and governed well, cities can be a source of employment, poverty alleviation, a better life for its citizens and therefore offer the potential to transform the emissions profile of country. To do so cities need: energy security; a diverse supply of energy sources; a lowering of carbon emissions; resource and energy efficiency; and must be economically competitive to achieve low carbon growth and development.

This section highlights the shifts that have taken place at the municipal level over the past ten years, provides an overview of what has changed and highlights the potential for further work to take place. Fundamentally, while municipalities have the ability to take mitigation measures to scale, policy direction and financial support at the national and international levels is critical for implementation and needs to be urgently addressed.

City-level action to date

Local governments have a key role in supporting implementation of policies to address energy poverty, energy efficiency, renewable energy, urban form and transport. Initiatives across these

[7] For more in-depth reviews of recent quantitative studies at the national, provincial, and city-scale, see the Appendix.

areas have depended on local level data collection, energy planning guidance, and sufficient capacity of local government staff.

Data collection and energy policy development

Sustainable energy development at the municipal level was first explored in South Africa around 1998, at the time of the development of the national White Paper on Energy Policy (1998) and White Paper on Local Government (1998). These guidance documents provided the foundation for national energy policy formation, with a focus on energy poverty alleviation and the diversification of supply to ensure energy security. The Cities Energy Declaration in the early 2000s challenged cities to set a course for a more sustainable energy path. Since then, efforts to expand local level data collection and energy strategy development have improved dramatically (Figure 6). This has been further supported by the Local Government Energy Efficiency and Renewable Energy Strategy, which provides guidance to municipalities, to develop their own strategies and policies relating to energy and climate change.

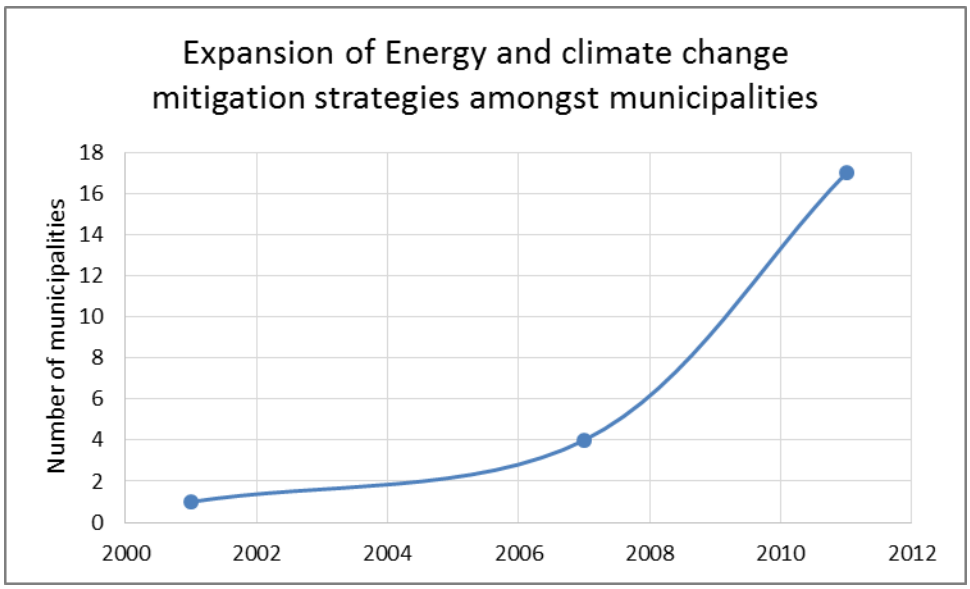

Figure 7: Expansion of energy and climate change mitigation strategies amongst municipalities in South Africa, 2000–2012

Local government capacity and skills

Increasingly there are dedicated local government staff focused on energy planning within newly created Energy and Climate Change units, either within Electricity or Environmental Departments, or in special units, such as the Sustainability Unit in the City of Tshwane. Often the positions span departments, which also enables a greater degree of critical, interdepartmental coordination. There are also examples of improved capacity of staff in other service delivery departments, through projects and initiatives. For example, in the cities of Ekurhuleni, eThekwini and Johannesburg, Waste Department officials are very involved in methane gas collection and gas to electricity generation initiatives. Public lighting retrofits in the City of Cape Town have drawn in the Roads Department and resulted in training of city-owned building managers in energy management harnesses this additional capacity.

An urban energy learning network pioneered and growing since 2003, has provided a space for municipal officials to come together and share lessons and information. A continuing professional development (CPD) course on Urban Energy has been running in Cape Town.

Despite this progress local government, in general, experiences an enormous shortfall in human capacity and skills. Work in this area will be ongoing.

Service Delivery

Key areas of local government service delivery that relate to the new energy and climate policy directions of national government include: energy access, energy efficiency, renewable energy, urban form and transport.

Energy access

Electrification in the country continues to be a priority project of all municipalities. As shown in Figure 7, there has been an increase in electrification from 2001 to 2011 particularly in the low income category. Electrification in the country increased from 36% in 1994 to 87% in 2012. Municipalities have taken a proactive role in the electrification process as well as in providing energy services in informal settlements.

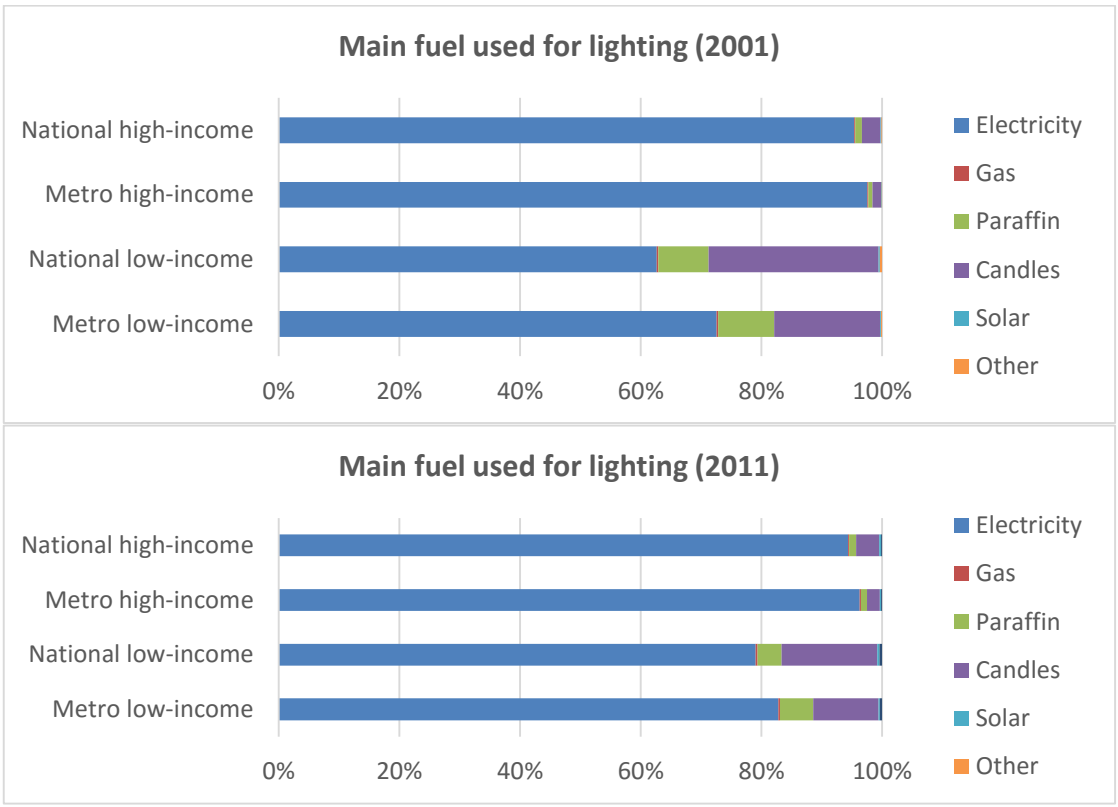

Figure 8: Electrification of households in South African municipalities (lighting is used as a proxy for electrification), 2001 – 2011 ***(Data Source: StatsSA 2001 and 2011)***

Energy efficiency

Many municipalities still do not routinely collect data on electricity consumption within their own facilities and operations and many do not even have equipment in place to do this. On average the total consumption of electricity by the municipality in the delivery of their services, ranges from 1% to 4% (usually the higher ranges in the smaller municipalities). There is an opportunity for improved efficiency of delivery by replacing outdated equipment and increasing the capacity in smaller and less efficient municipalities.

A growing number of municipalities are undertaking efficiency retrofits of municipally owned/operated buildings, facilitated largely through funding from the national Department of Energy's Electricity Efficiency Demand Side Management (EEDSM) Programme. Substantial retrofits and related savings have been realized, indicating the central importance of this programme as a catalyst for change. The programme funds municipal efficiency implementation and has, in response to municipal needs, expanded from public lighting to building and wastewater treatment pump retrofits. The programme is extremely important for the country and could benefit from a greater degree of alignment with local policy and strategic direction.

With regard to private sector buildings, building plan approval and regulation is a municipal mandate. New regulations developed in 2013 were extended to include low income, government delivered housing. The regulation requires that new buildings comply with energy efficiency requirements. Metros, such as Tshwane, Johannesburg and Cape Town, have taken this further and developed local "additional" green building guidelines for developments.

More sustainable housing development initiatives have also been pioneered in a number of locations around the country. The Joe Slovo Sustainable Housing Development (a flagship National Human Settlements project) for low-income households in the City of Cape Town was designed with the intent of appropriate densification and included the implementation of a number of energy efficiency interventions notably the installation of ceilings[8], efficient lighting and solar water heaters. This resulted in improved quality of life, lower energy and transport costs and, greater access to social and economic opportunities (given this development is close to the city centre) and a lower carbon footprint overall (SEA, 2013).

Renewable Energy

While in general, South African municipalities cannot influence energy supply and therefore have limited opportunities to pursue renewable energy opportunities, larger metros have embarked on utilising their waste (waste water and solid waste) 'assets' for gas to electricity projects; and rooftops for PV development for their own building operations. The motivation behind these projects is both economic due to South Africa's electricity supply crisis and steep electricity price increases, and driven by environmental and sustainable energy issues. Further this has resulted in the development of new skills sets, improved waste management, and provided visible leadership in new, sustainable directions. The acceleration of project development shown in Figure 8 mirrors the acceleration of capacity amongst municipal officials and service providers to engage in new technologies and business models.

[8] The government delivered housing from 1994 until 2012 did not require the installation of ceilings which impact hugely on the thermal efficiency of houses, human health as well as from an aesthetic perspective.

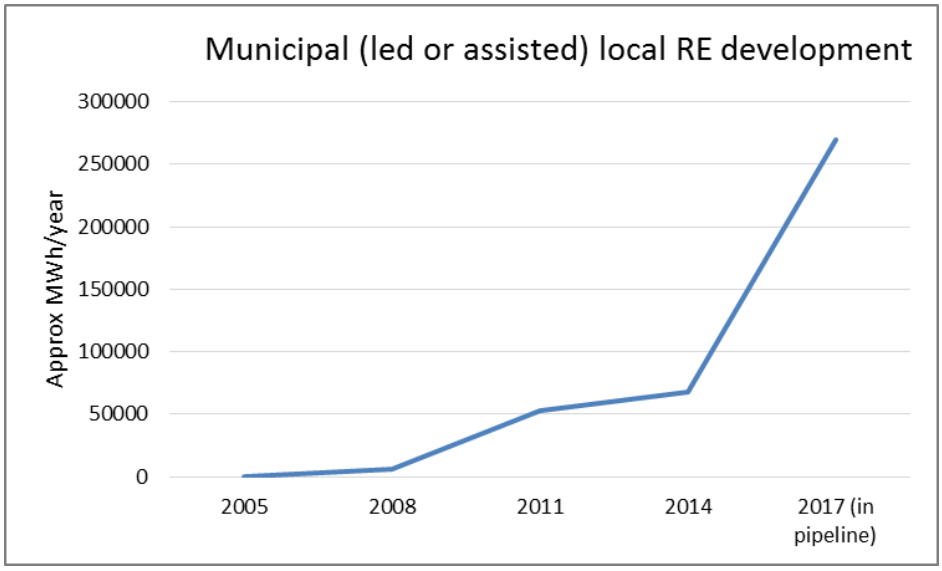

Figure 9: Growth of municipal (led or assisted) local renewable energy development 2005 - 2017

Municipalities are also exploring their role in encouraging private renewable energy development through the development of application guidelines and procedures relating to small-scale embedded generation (SSEG) (less than 100kw). The larger metros have developed procedures and are now accepting SSEG applications and a number of municipalities have been thoroughly engaged in the finalisation of the NERSA guidelines. Municipalities are also exploring their role in brokering opportunities between generators and willing buyers (greater than 100kw). NERSA guidelines on this are currently under discussion and development.

The metros of Ekurhuleni, eThekwini and Cape Town all have a target of 10 – 15% renewable energy within their electricity mix within the next ten or so years. Ekurhuleni, in particular, has submitted an ambitious plan to council, detailing steps to achieve the development of 260MW of renewable energy capacity within the metro area. It is interesting that municipalities all have slightly different approaches in the area of local renewable energy development, thus facilitating a degree of experimentation and innovation, through which best practice will emerge.

Transport and urban form

There are select examples of important public transport interventions, nevertheless across the country urban transport is still largely characterized by inefficient, congested roads and a dependence on private vehicles. The City of Johannesburg's "Corridors of Freedom" initiative is undertaking exactly this sort of radical transformation of urban space: "Over the decade we will introduce transport corridors connecting strategic nodes through an affordable and accessible mass public transit that includes both bus and passenger rail. These corridors will include mixed income housing, schools, offices, community facilities, cultural centres, parks, public squares, clinics and libraries." (City of Johannesburg, 2012)

3. NEXT STEPS TO ACHIEVE URBAN ABATEMENT IN SOUTH AFRICA

National policy changes are needed to enable urban abatement

New national policy directions introduced after 1994, notably those relating to climate change, developmental local government, integrated energy planning, renewable energy development and energy efficiency, by necessity required a whole new level of collaboration with local government, as this is where much of the implementation and development must happen. A new level of collaboration and vertical integration between national and local governments is required to fully realize the potential for urban abatement.

The constitutional authority given to local government includes providing services to communities in a sustainable manner, the promotion of social and economic development, and a safe and healthy environment. The Constitution also sets out the powers and functions of municipalities, which include some aspects relating to air pollution, building regulation, electricity and gas delivery, municipal planning and street lighting. These functions all have strong energy-related implications. Therefore, as municipalities derive authority from the Constitution to intervene in these matters, they are empowered to develop policy and legislate on energy efficiency and renewable energy dimensions relating to these powers and functions within their jurisdiction. The Municipal Systems Act (2000) requires municipalities to produce integrated development plans for the medium-term development of their municipal areas to meet the needs of their communities. The Act directs municipalities to provide sustainable services to their communities and promotes increased community involvement in the provision of energy services. For many municipalities this allows for the development of detailed energy and climate change strategies.

However, the national legislative environment also poses numerous challenges for municipalities attempting to implement these initiatives. This includes a lack of clarity as to the role/mandate of municipalities in implementing energy efficiency and renewable energy measures. For example, some policies might set targets for the implementation of energy efficiency and renewable energy at a national level, without clearly identifying the municipal mandate and associated financial resources. If municipalities are expected to contribute, as is broadly indicated in policies, these responsibilities need to be translated into specific key performance areas (KPAs) within municipal management systems. In turn, the Municipal Finance Management Act regulates municipal procurement procedures and has proved challenging in relation to the demands of both energy-efficiency and renewable-energy project implementation, which often requires long-term contracting. In addition cities are only able to generate electricity for their own use but not for sale to customers within their jurisdiction.

Many municipalities that are also electricity distributors generate income through the sale of electricity. A sizeable issue for municipalities is the impact to their revenue base imposed by introducing efficiency and renewable energy development.

Cities hold clear levers for GHG abatement, and as has been reported they consume large amounts of energy. They are the seat of delivery and implementation of many national policies and are the sphere of government closest to the communities they serve. They are well poised to implement and much has been undertaken. However, cities remain handicapped in their authority to realize mitigation potential at scale.

Local officials believe strongly that municipalities, no matter what size, must lead by example in the move towards sustainability and energy efficiency; however, they also know the reality is one where, unless dedicated funding is allocated from national government for local initiatives, it is unlikely that this work will be given priority where it matters – in municipal budget allocations. In addition, the different departments have their own mandates and own

pressures, there needs to be an alignment and cooperation not only with each sphere of government but from a vertical perspective between local, provincial and national government.

The ingredients for change are there: leading municipalities are developing strong political support for this development direction and resources and capacity are being directed to support these imperatives. Diverse experiments and innovations are underway, a space for lessons sharing is in place, courses and curricula for new skills and "re-skilling" of current professionals and officials is underway, partnerships are developing between municipalities, provincial and national government, NGOs, universities and other stakeholders. Despite this there remains much work to be done.

Further, the development of sustainable energy is challenging, as it does not often speak directly to the immediate needs and priorities of residents. On a day to day basis, climate change is not a priority, yet mitigating disastrous levels of climate change is critical for survival. Thus the transition and systemic change requires a high degree of leadership, innovation and partnership. Municipalities are large bureaucracies, with complex legal frameworks and systems of accountability, with close interface with citizens and vulnerable to political interference.

National policy is all too often playing catch-up with local developments. Clarity on many policy issues, relating to renewable energy development, is vital for greater action within municipalities (e.g. generation for 'own consumption', regulations relating to grid use and issues/concerns around the privatisation of aspects of electricity distribution). Municipal energy efficiency and renewable energy programmes need to be given proper policy attention at a national level. In particular, if national policy is not sufficient to transform the power supply to low-carbon electricity, then the role of local government as an agent to purchase and/or generate renewable energy should be considered.

Challenges that remain revolve around the institutionalising of sustainable energy work in municipal practice, associated capacity development in local government, and greater coordination and support from national government at the local government level. This entails an alignment of policies across all three spheres of government and better coordinate actions across government levels. South Africa has several options for polices to meet the development priorities and reduce emissions, the challenge has been implementation. Leadership from the national government is need to enable action at the local and provincial levels.

4. CONCLUSION

Cities have a critical role to play in transforming South Africa's GHG emissions profile. An urgent and sustained effort is needed to change how resources are used and to transition to a low carbon economy – all in a very short timeframe. It is increasingly apparent that national government will need the strong support from local government to meet national emission reduction targets.

As presented here, there is evidence of promising action by South African cities to improve energy efficiency and reduce emissions. In many cases cities have moved beyond pilot implementation and are mainstreaming more sustainable practices, but challenges remain to realize these interventions at scale. Cities in South Africa have substantial power and opportunity to transform the energy profile of the country, yet significant systemic changes within and between all three spheres of government are required in order to fully realize the opportunities.

Looking beyond the detail of the past decades' important move from policy to implementation, the next new frontier for this work will be to move the work and approaches from a slightly marginal concept of emissions reduction to the heart of the city's planning engine: squarely

promoting an urban infrastructure, economy and form that accelerates integration and access to social and economic resources while ensuring sustainability and developing a low carbon economy. This may also entail shifts between the spheres of government whereby national government enables local government to take additional powers relating to local electricity generation and financing. It requires strong partnerships between business, civil society and all three spheres of government. It requires awareness and consciousness of what needs to shift. It requires getting practical and supporting that practice with the right policies, the right regulations and the right skills and capacity development.

With this support in place, clear implementation measures and the vertical integration links at the national and provincial levels would be critical to the success of meeting South Africa's climate response objectives and targets.

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APPENDIX

National, provincial, and municipal level abatement – summary of recent research

The three abatement studies presented here reflect the strong alignment between all three spheres of government, in supporting the country's overall commitments to lowering carbon emissions. All three studies illustrate that the energy and emissions growth patterns within a Business As Usual trajectory are unsustainable and highlight the need to focus on mitigation in the electricity supply sector. The national study provides an aggregate picture for the country and provides overarching direction for implementation within the other two spheres of government. The local level provincial study provides the crucial detail of the work required to enable implementation of low carbon interventions on the ground. Finally, the City of Cape Town Optimum Energy Future's study details a basket of feasible interventions to be implemented for each sector, under different low carbon emission scenarios, and unlike the other two studies is focused on implementation. A short summary of all three studies is provided below.

National government: South Africa's greenhouse gas mitigation potential analysis study

The Department of Environment Affairs (DEA) developed a national GHG mitigation potential analysis for the country which was adopted by the South African government in July 2014. The study outlines potential low-carbon pathways and their impact on the country's emissions profile between 2010 and 2050. It includes the many energy intensive industries present in South Africa. The study provided an updated assessment of the mitigation options in the national LTMS and was able to include importantly the wider socio-economic and environmental impacts of the mitigation options available.
The three key mitigation scenarios outlined in the analysis are as follows:

- Without Measures Scenario (WOM) which assumes the absence of climate change mitigation action between 2000 and 2050
- With Existing Measures Scenario (WEM) which assumes the impact of climate mitigation actions to date
- With Additional Measures (WAM) which assumes up to 100% implementation of all identified mitigation options in addition to existing actions.

The Mitigation Potential Analysis Report (2014) points to the electricity supply and the industrial sectors respectively as key sectors intended to make the largest contributions to GHG emissions abatement by 2050. These findings are not surprising given the high energy intensity of the national economy and the continued use of coal in South Africa's electricity production. The Report importantly points out that assuming all abatement measures are implemented, GHG emissions are expected to decline in absolute terms between 2020 and 2030, and are thereafter projected to rise again. The Report states that "a more aggressive decarbonisation of South Africa's electricity supply sector will have to be targeted as part of the process of updating the Integrated Resource Plan[9] (IRP), to achieve an absolute reduction in GHG emissions relative to current levels, or a more ambitious emissions reduction target (such as PPD) is to be achieved." (DEA, 2014) The intention is that the Report will assist national

[9] The Integrated Resource Plan (IRP) is South Africa's overarching strategic Electricity Plan over a 20-year period. The current IRP 2010 was revised in 2013, but this document has not yet been approved by National government.

government with identifying appropriate actions going forward in the context of South Africa socio-economic development realities.

Provincial government: Western Cape Province long term mitigation scenarios

The Western Cape provincial Government's Climate Change Mitigation Scenarios developed in 2015 explored three scenarios which are also closely aligned to the DEA Mitigation Potential Analysis Study (discussed above). The Province's scenario projections however were up to 2040. The **Reference Case Scenario** assumed a continuation of Business As Usual in terms of energy consumption and GHG emission patterns. The second scenario involved '**All Possible Measures' (APM),** which assumed the implementation of the most feasible set of energy efficiency measures along with small-scale embedded electricity generation from renewable energy sources. The third scenario, **'All Possible Measures with Fuel Switching' (APMF)** assumed a shift from coal-generated electricity to gas-generated electricity. All three mitigation scenarios are premised on basis that the drivers of energy demand are population, household and economic growth.

The implementation of **APM Scenario** was shown to yield a 29% reduction in energy demand relative to the Reference Case. Under this Scenario energy consumption would increase at an average annual growth rate of 1.3% until 2040, relative to the 2.5% increase per annum in the Reference Case. The sectors showing the greatest reductions in energy demand compared to the Reference Case Scenario are, 1) the transport sector in particular passenger transport – a 31% reduction in energy demand by passenger transport, and 2) the industrial sector - 25% reduction in energy demand.

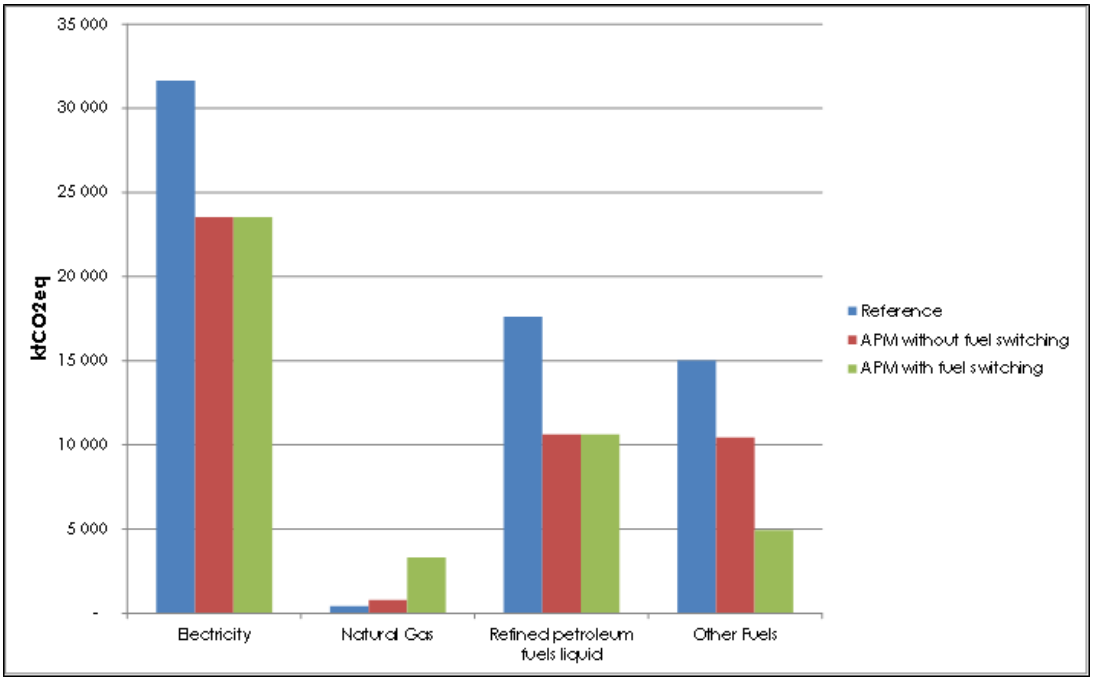

Figure 10: Modelled GHG mitigation scenario comparison for the Western Cape Province – emissions by fuel type in 2040 (in ktCO2e)

The primary conclusion from this study is that, with all possible measures applied, other than fuel switching, there is the potential to reduce emissions substantially from a rate of increase of 2.3% per annum under the Reference Case Scenario to an average annual increase in emissions of 1.1% over the period up to 2040. Further, should the province simultaneously implement 'All Possible Measures with Fuel Switching', an even greater opportunity arises to reduce emissions, with the average annual increase in emissions reduced to 0.9%. While it is shown

that it is not feasible to avoid an increase in emissions associated with energy use in the Province, this is a substantial reduction." (WCPG, 2015) (See Figure 10). In other words, despite these measures, as with the National Mitigation Potential Analysis Study, GHG emissions in the Western Cape will continue to rise beyond 2040 (see Figure 11). This Provincial Study further states that meeting these required emission reductions requires substantial investments costs in the implementation of mitigation interventions.

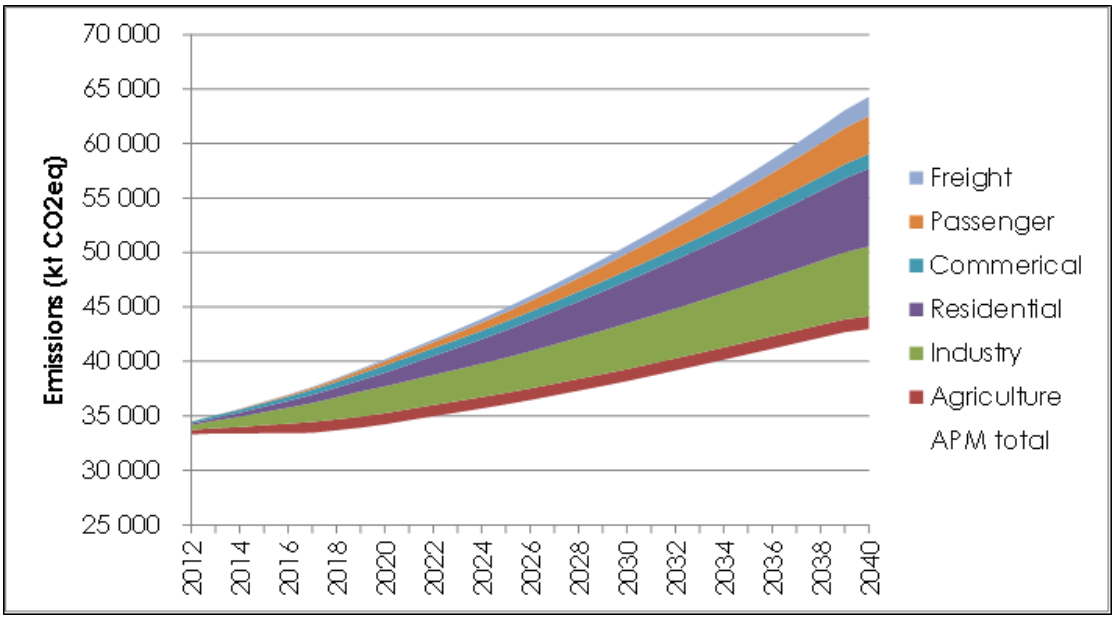

Figure 11: Projected GHG emissions savings potential by sector for the Western Cape Province by 2040

Local government: City of Cape Town optimum energy future

The City of Cape Town (CCT) undertook a Mitigation Potential Energy Modelling Study in 2015 which included the development of a detailed energy and GHG emissions assessment of the City. This study was undertaken to inform an Energy 2040 Vision of the City.

Cape Town demographics

In 2011 Cape Town's population was at 3.7 million. Between 2001 and 2011 the annual population growth rate was 2.6%. Close to half of the population (47%) are poor. Cape Town is home to 8% of the national population and two thirds (64%) of Western Cape Provincial population. The City generates close to three quarters (73%) of economic wealth of the Province, yet energy consumption in Cape Town is only half that of the Province. This is likely due to the composition of Cape Town's economy which is dominated by tertiary sector activities (low energy intensities) and limited heavy industry.

Cape Town's energy and emissions picture by energy source

City of Cape Town's energy consumption picture is typical of most metros in South Africa. Petrol and diesel (transport fuels) constitute more than half of all energy consumed in the city, with electricity accounting for the bulk of the remainder. Electricity produces more GHG emissions per unit energy consumed relative to transport fuels due to the fact that it is largely generated from coal-fired power stations using low-grade coal.

Between 2001 and 2012 total energy consumption in Cape Town grew by 26.8% at an average annual rate of 2.2%. Growth in annual energy consumption has, however, been lower than both population (2.6%) and economic growth (4%) in the City over this period. As can be seen in

Figure 8 below energy consumption in the transport sector has grown over time and electricity has been declining since 2007, the latter possibly in response to steep electricity price increases and frequent load-shedding events as result of the national electricity supply crisis.

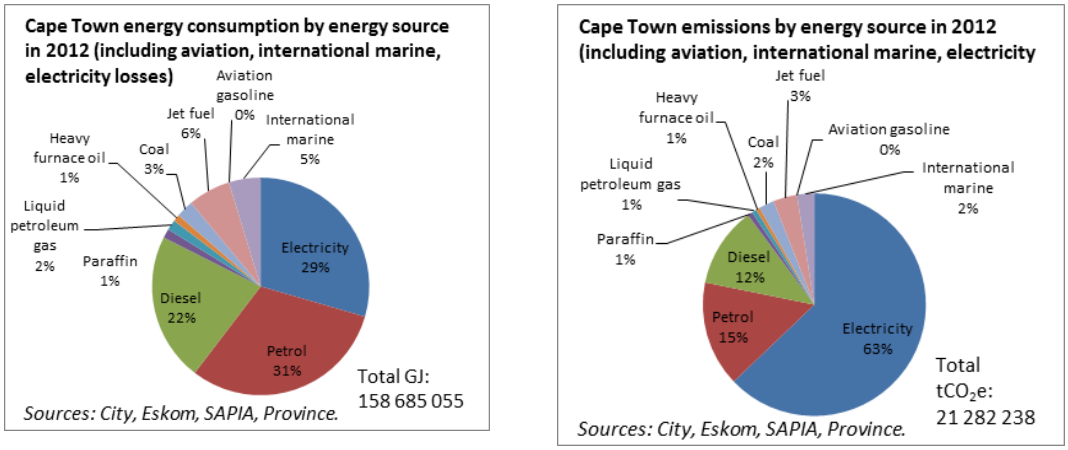

Figure 12: City of Cape Town energy and emissions by energy source, 2012

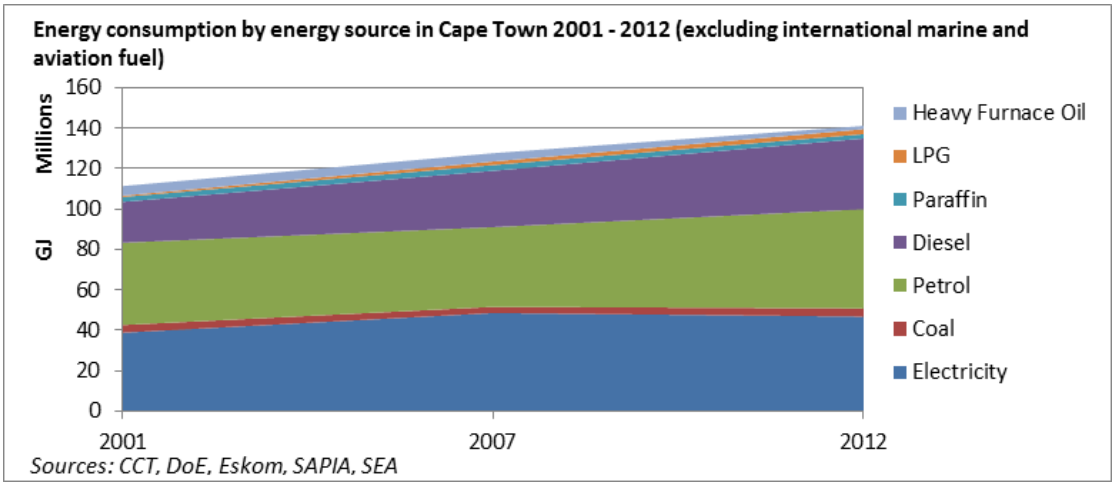

Figure 13: Energy consumption over time for the City of Cape Town[10]

Although Cape Town's energy-related GHG emissions have increased in absolute terms since 2001, *per capita* emissions have declined from 5.7 tCO_2e in 2001 to 5.2 tCO_2e[11] in 2012 (a 10% reduction), due to population growth surpassing growth in energy consumption. This declining trend would also have been influenced by the decrease in electricity consumption over this time period.

Cape Town's energy and emissions picture by sector

Sector GHG emissions and energy consumption are shown in Figure 12. The residential and commercial sectors make up nearly half of Cape Town's emissions and a quarter of the city's energy consumption. Transportation, including aviation and marine uses, is responsible for a third of the city's emissions and 64% of the city's energy consumption. The industrial sector make up 11% of the city's emissions.

[10] Aviation and international marine fuels excluded, as data for these fuels vary significantly over time, making them unreliable

[11] This is exclusive of international marine and aviation fuels for purposes of comparison – data for these fuels were not included in the 2001 State of Energy in South African Cities Report.

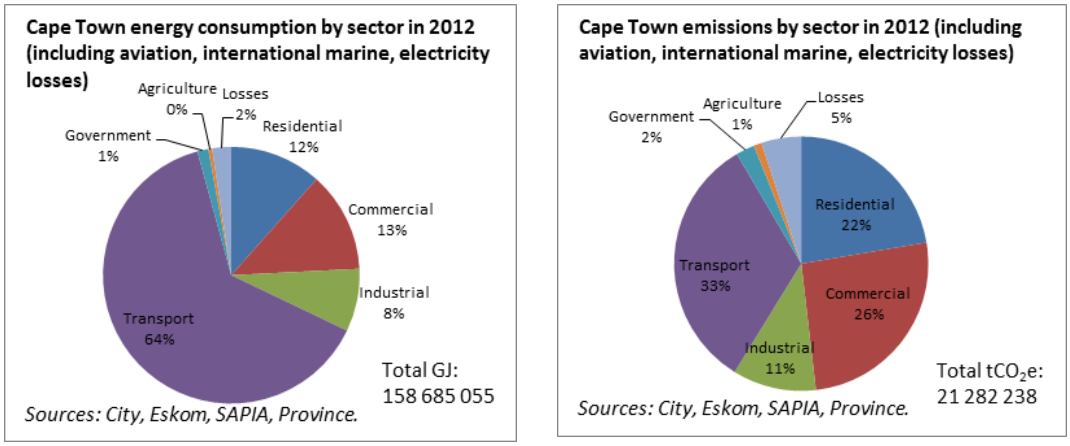

Figure 14: Energy and emissions by sector for the City of Cape Town, 2012

Households account for 12% of total energy consumed in the City, and 37% of total electricity used within the City boundary. A quarter of all the City's households (mainly high-income households) account for approximately 50% of residential energy demand, and half of all households (mainly low income households) account for only a quarter of the residential energy demand (see Figure 9). This finding brings to light two critical issues: 1) the majority of households in Cape Town are consuming comparatively very little energy, indicating in this context a continued level of energy poverty within the City while 2) an overconsumption of energy is occurring among high income households of Cape Town. Cape Town households mostly rely on electricity for their household energy requirements: lighting, space heating, cooking and water heating. Multiple fuel use does persist amongst poor households. However, paraffin consumption has reduced substantially since 2007 (25% reduction) as a result of the National Electrification Programme. 30-40% of mid to high income households' energy consumption is for *water heating purposes*. The decrease in electricity consumption at the metro level is largely driven by the residential sector.

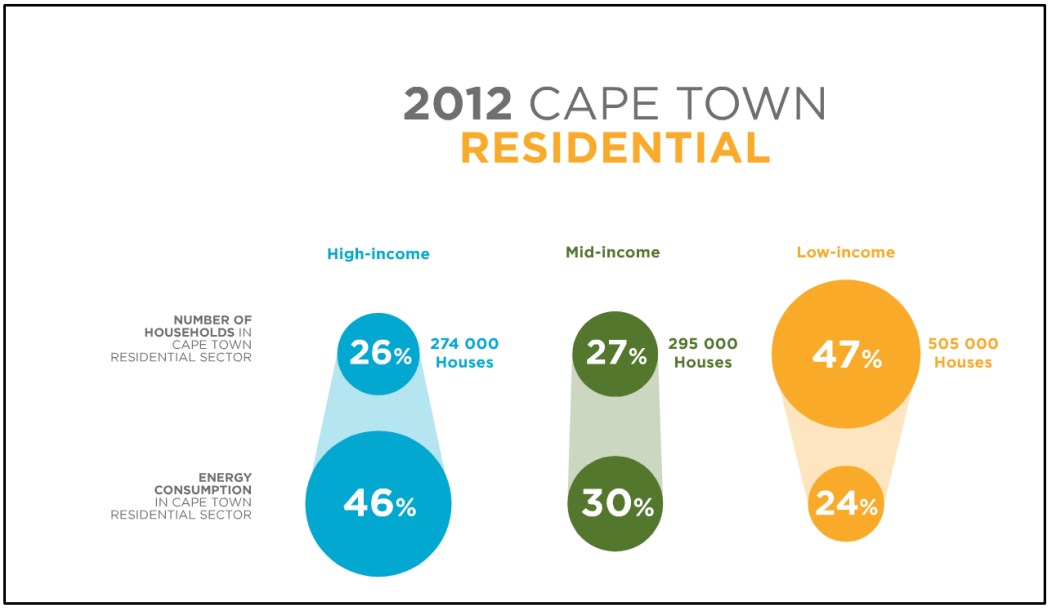

Figure 15: Residential sector energy consumption in relation to the proportion of households by income group *(City of Cape Town 2015a)*

Together the **commercial and industrial** sectors consume 21% of total city energy. Within the commercial sector (the economic "engine" of the city), which is heavily reliant on electricity, consumption has plateaued over time despite continued economic growth. A "decoupling" of the economic growth from energy consumption is observed for the City. The commercial sector consumes electricity predominantly for HVAC and lighting purposes. Cape Town does not have a large industrial base (relative to other metros such as Durban), which is why the industrial sector consumes the least amount of energy relative to all the major sectors.

The **transport sector** accounts for 64% of all energy consumed in the city. This is shaped by the urban spatial form of the City, which is characterized by low-density development and an historical emphasis on road-based transport. Passenger transport dominates, accounting for 81% of transport energy share (excluding marine and aviation fuels). Of this, 91% of the energy is consumed by *private* passenger (with a component being small, commercial vehicles)[12] and only 9% is consumed by *public* passenger transport (see Figure 11). This is in sharp contrast to the fact that 54% of the City's households do not own car. Given the decline in electricity consumption since 2007, overall growth in Cape Town's energy consumption has been driven by growth in consumption of transport fuels.

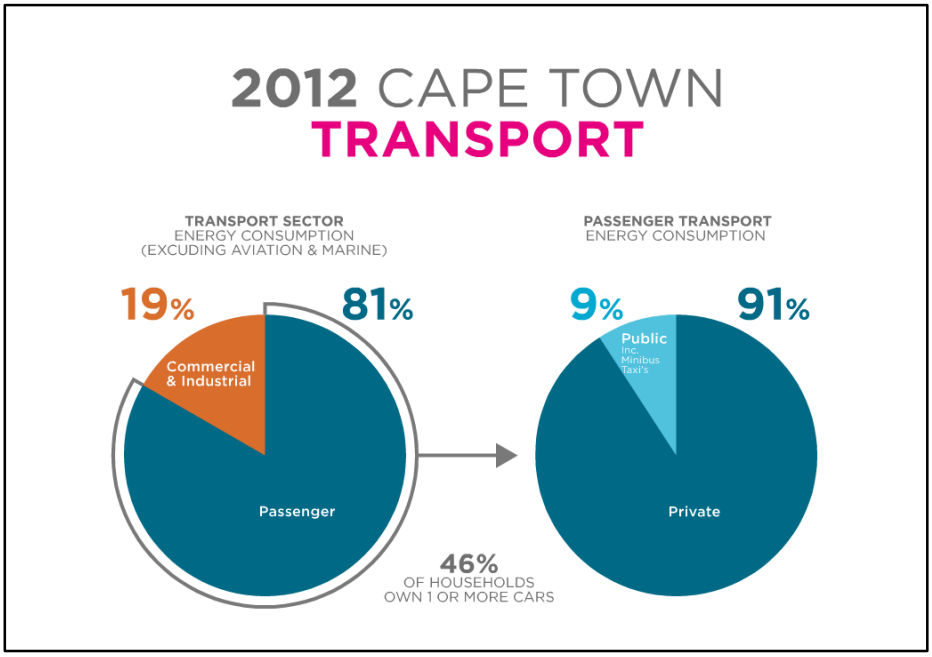

Figure 16: Private-public modal split relative to fuel consumption for the City of Cape Town (City of Cape Town 2015a)

Looking to the future: An Optimum Energy Future for Cape Town

The City of Cape Town has developed an Optimum Energy Futures Model which details the mitigation potential for the City as part of its Energy 2040 vision. The model shows that the risks of following a *Business as Usual* scenario will result in an alarming doubling in energy consumption by 2040 (see Figure 12). Emissions are also expected to increase under the *Business as Usual* projections (see Figure 13). A *Business as Usual* pathway would place cost

[12] It was very difficult to split petrol and diesel use by light passenger vehicles into usage by private individuals and by commercial entities (e.g. rental car hire companies, small businesses such as plumbing and gardening services, etc.). Indications are that this may account for 10% of passenger transport (with public at 9% and private passenger transport reduced to 81%).

constraints on economic growth, while burdening households with unnecessarily high energy costs. High levels of traffic congestion would lower the 'liveability' of the city. Emissions levels would contribute to global climate change of catastrophic proportions.

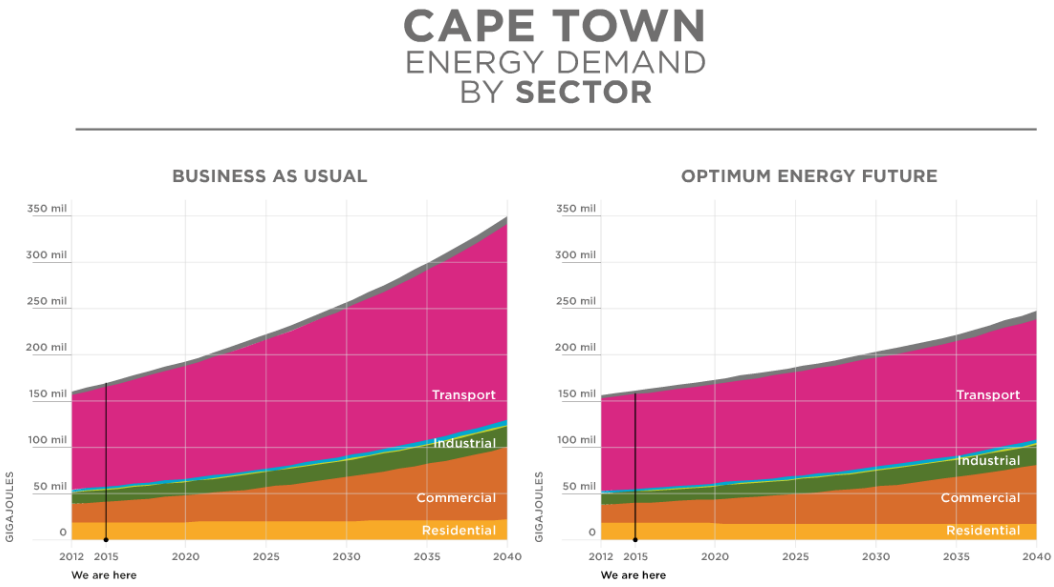

Figure 17: Business as Usual trajectory relating to energy demand and emission by sector for the City of Cape Town

In order to align the City's future with current City visions and national priorities and plans such as PPD, alternative scenarios were considered all in line with a low carbon and resilient city.

The model indicates that the largest energy demand reductions will arise from the transport sector, since it is the largest energy consumer in the City. Emissions reductions in the commercial sector will also have significant results. Energy efficiency measures alone will not substantially alter the emissions pathway by 2040. The model points to the need to move towards cleaner and renewable electricity generation in order for the GHG emissions reduction curve to be in line with national PPD trajectory. The costs of energy under an Optimum Energy Future will be reduced by R150 billion by 2040 (City of Cape Town, 2015b).

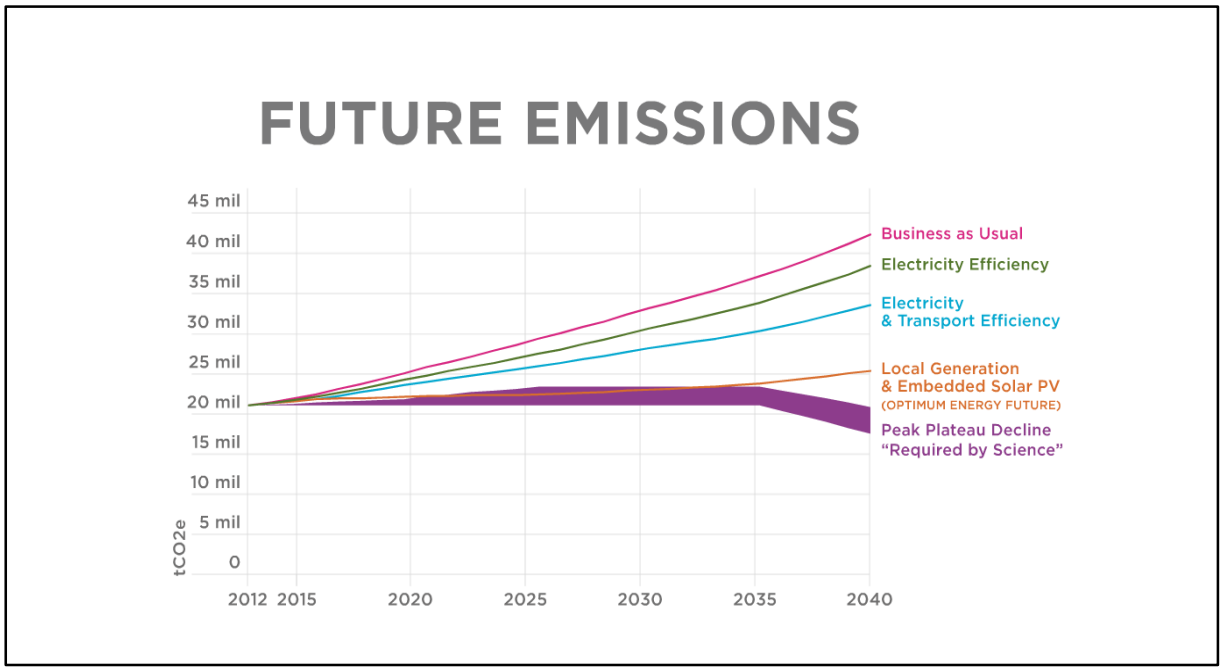

Figure 18: Scenarios vs. required by science emissions pathway (2012-2040) for the City of Cape Town

In order to achieve an Optimum Energy Future that results in a 40% reduction in carbon emissions, the City of Cape Town will need to undertake the following measures:

- Reduce its energy intensity by 16%;
- Aggressively introduce energy efficiency interventions in all sectors;
- Diversify energy supply, with the introduction of local electricity generation from gas, wind, solar PV and rooftop PV. The intention being to scale down the purchasing of national generation and increase own supply through larger-scale local generation and alternative energy sources, such as gas and wind;
- Ensure the installation of half a million solar water heaters (SWHs);
- Introduce energy efficient vehicles, encourage modal shifts from private to public transport, and promote high private passenger occupancy
- Improve and increase access to public transport

All of the interventions modelled are feasible and have economic, social and environmental benefits for the City. However, such an Optimum Energy Future requires bold decision-making, innovation, strong leadership and finance. In particular, elements that sit outside of the City's control will need to be addressed at the national level. For instance given that that cities are obliged to purchase bulk electricity from Eskom (South Africa's single electricity generating utility) and NERSA (South Africa's energy regulating body) would have to adjust regulations to enable local government to generate electricity.