CAPE TOWN
STATE OF ENERGY
2015

CITY OF CAPE TOWN
ISIXEKO SASEKAPA
STAD KAAPSTAD

Making progress possible. Together.

Document navigation shortcuts

- Entries on the Contents pages link to the relevant page.
- The tabs on the right-hand pages link to the first page of the relevant section.
- The document title in the footer of each page links to the first Contents page.

This document is available from the City of Cape Town's Environmental Resource Management website at: http://www.capetown.gov.za/en/EnvironmentalResourceManagement/publications/Pages/default.aspx.

FOREWORD

There is little doubt that we are entering a new era in terms of energy. Our energy future requires a strong commitment to identify and implement innovative and sustainable responses. Local governments are in a key position to steer this change and generate considerable impact through effective awareness-raising and the implementation of more efficient and sustainable energy solutions.

The City of Cape Town is committed to tackling these challenges head-on, and continues to work towards a future that will increase resource efficiency, secure long-term energy supply and, at the same time, increase its citizens' quality of life. Cape Town's Energy and Climate Action Plan is our path towards such an energy-secure future and vibrant city.

Sound data-gathering has been central to building a reliable energy profile and a baseline emissions inventory for the City over the years. This strengthens the foundations of Cape Town's action planning and future energy vision. It is also critical for the ongoing monitoring and evaluation of programmes and projects, the identification and prioritisation of projects and the establishment of energy and climate targets to honour all the global pacts, partnerships and agreements on climate change mitigation to which the City is a signatory (including the Mexico City Pact and the C40 Climate Leadership Group) as well as to report to the Carbon Disclosure Project (CDP) and carbon*n* Climate Registry (cCR).

Cape Town has been commended for the quality of its data on both of the aforementioned reporting platforms and was selected as Global Earth Hour Capital from amongst 163 entrants in 2014. This award was an exceptional accolade in recognition of Cape Town's innovative work on energy and climate reporting as well as our dedication to pursue the goal of a sustainable urban environment, while showing that it is possible to have a thriving, dynamic economy at the same time.

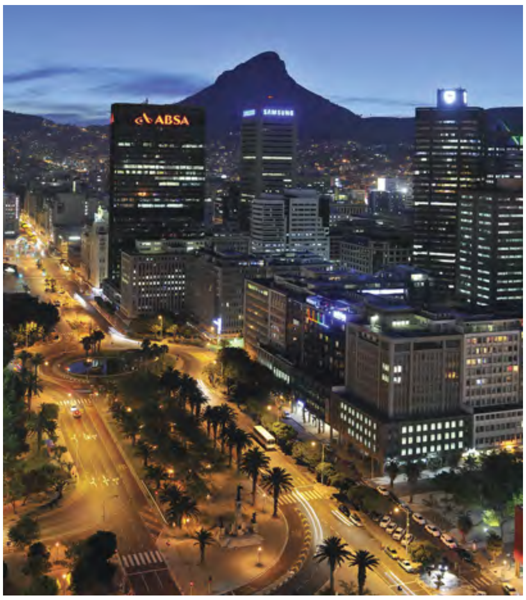
To demonstrate our commitment to continue our pioneering work, the City is aiming to actively participate in the Compact of Mayors – a commitment by cities to reduce carbon emissions and promote green economies and cleaner technologies.

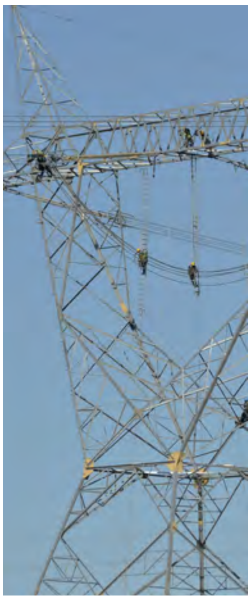
The efforts of a growing number of cities setting the example at national and international level not only show commitment to sustainable development, but also serve as an inspiration to other cities. Cape Town's energy work holds great potential to inspire other cities as well as its own citizens, business community and civic organisations to work together with the City on its journey towards building a more resource-efficient and resilient future for our city.

P. de Lille

Patricia de Lille
Executive Mayor

TABLE OF **CONTENTS**






A8
1018

FIGURES AND TABLES

FIGURES

TABLES

ABBREVIATIONS AND DEFINITIONS

City	The City of Cape Town (i.e. the municipality as a governance structure)
city	Cape Town (i.e. the whole city)

AFOLU	agriculture, forestry and land use
AGT	Athlone gas turbine
BAU	business as usual
BFP	basic fuel price
BRT	bus rapid transit
CBD	central business district
CCT	City of Cape Town
CFL	compact fluorescent light (bulb)
CO_2	carbon dioxide
CPI	consumer price index
CSP	concentrated solar power
CTSDF	Cape Town Spatial Development Framework
DANIDA	Danish International Development Agency
DoE	Department of Energy
DORA	Division of Revenue Act
ECAMP	Economic Areas Management Programme
ECAP	Energy and Climate Action Plan
EE	Energy efficiency
EEDSM	Energy Efficiency Demand Side Management Programme
ERMD	Environmental Resource Management Department
FBE	free basic electricity
GDP	gross domestic product
GHG	greenhouse gas
GIS	geographic information systems
GJ	gigajoule
GPC	Global Protocol for Community-Scale Greenhouse Gas Emission Inventories
Gt	
GWh	gigawatt-hour
GVA	gross value added
HFO	heavy furnace oil
HVAC	heating, ventilation and air-conditioning
IBT	inclining blocked tariff
IEP	Integrated Energy Plan
IPCC	Intergovernmental Panel on Climate Change
IPP	independent power producer
IPPU	industrial processes and product use
IRP	Integrated Resources Plan
IRT	integrated rapid transit
kg	kilogram
koe	kilogram of oil equivalent
KPA	key performance area
kWh	kilo-watt hour
kWp	kilowatt-peak
kVA	1000 volt amps
ℓ	litre
LEAP	Long-Range Energy Alternatives Planning
LED	light-emitting diode
LPG	liquid petroleum gas
LPU	large power user
MW	megawatt
MWh	megawatt-hour
Mt	megatonne
MYPD	multi-year price determination
NDP	National Development Plan
NERSA	National Electricity Regulator of South Africa
NETFIT	nett feed-in tariff
NMT	non-motorised transport
NO_x	generic term for the mono-nitrogen oxides NO and NO_2
NNP	National Polar-orbiting Partnership
OCGT	open-cycle gas turbine
PetroSA	Petroleum, Oil and Gas Corporation of South Africa
$PM^{2,5}$	particulate matter up to 2,5 micrometres in size
PM^{10}	particulate matter up to 10 micrometres in size
PPA	power purchase agreement
PPP	public-private partnership
Province	Western Cape Provincial Government
PV	photovoltaic
RGT	Roggebaai gas turbine
REIPPP	Renewable-Energy Independent Power Producers Programme
SALGA	South African Local Government Association
SAMSET	Supporting Sub-Saharan Africa's Municipalities with Sustainable Energy Transitions
SAP	Systems, Applications, Product (computer program)
SAPIA	South African Petroleum Industry Association
SEA	Sustainable Energy Africa
SO_2	sulphur dioxide
SPS	Steenbras pumped storage
SPU	small power user
SSEG	small-scale embedded generation
Stats SA	Statistics South Africa
SWH	solar water heater
tCO_2e	tonnes of CO_2 equivalent
TCT	Transport for Cape Town
UNFCCC	United Nations Framework Convention on Climate Change
VOC	volatile organic compound
WCG	Western Cape Government
WWTW	wastewater treatment works
ZAR	South African Rands

ACKNOWLEDGEMENTS

The Cape Town *State of Energy* 2015 report is a collaborative product of the Environmental Resource Management Department of the City of Cape Town and Sustainable Energy Africa (SEA). The City would like to express its immense gratitude to SEA for the further support that it was able to provide to the project through the Supporting Sub-Saharan Africa's Municipalities with Sustainable Energy Transitions (SAMSET) project of which Cape Town is a member city (SAMSET is funded by the United Kingdom's Department for International Development and Engineering and Physical Sciences Research Council) and the City Energy Support programme (funded by Bread for the World). Without this additional funding and technical support, this study would have been much the poorer.

The authors would also like to thank all those City departments and other stakeholders who contributed time and information. Particular thanks to Eskom for making available Eskom distribution data and to the Department of Energy for the data on liquid fuels for the Cape Town area.

We are extremely pleased with the quality that has been achieved in this third iteration of Cape Town's *State of Energy* report. This report sets a new standard of energy data and analysis, which will be invaluable in understanding the critical energy issues facing Cape Town in planning for the future. This dataset also forms the basis of the Cape Town Energy Futures Study 2015, on which the Cape Town Energy2040 vision has been developed.

Authors

Sustainable Energy Africa: Megan Euston-Brown, Zanie Cilliers

City of Cape Town: Lizanda van Rensburg, Sarah Ward

Photography: Bruce Sutherland, City of Cape Town (unless otherwise stated)

Design and production: Creative Store

Published by the Integrated Strategic Communications, Branding and Marketing Department, City of Cape Town

SUSTAINABLE ENERGY AFRICA

SAMSET Supporting Sub-Saharan Africa's Municipalities with Sustainable Energy Transitions

Sustainable Energy Africa (SEA) is a non-profit organisation that has been working with South African cities on sustainable energy issues since 2000 and was instrumental in introducing the concept of energy thinking into city planning and strategic direction. SEA pioneered city energy data and strategy development in South Africa and facilitates implementation of sustainable energy and climate change programmes and strategies through capacity-building and support of city staff and undertaking action-research to address barriers to effective implementation.

This document is printed on paper sourced from sustainable and internationally certified plantations that use independently-audited chains of custody, such as the Forestry Stewardship Council and the Programme for the Endorsement of Forestry Certification, and the bleaching process is elemental chlorine-free.

A PDF edition of this document is available from the City of Cape Town's Environmental Resource Management website at: http://www.capetown.gov.za/en/EnvironmentalResourceManagement/publications/Pages/default.aspx.

1 EXECUTIVE **SUMMARY**

Cape Town's Energy and Climate Change Strategy focuses on three major aspects of sustainable energy: energy efficiency improvements, renewable energy promotion and increased access by the poor to safe, modern and affordable energy.

In response to global and national imperatives linked to sustainable energy, the City of Cape Town developed South Africa's first Energy and Climate Change Strategy in 2006. Since then, this endeavour has steadily risen in profile and received increasing political attention, with the development of several *State of Energy* reports, updated strategies, detailed energy modelling and a focus on implementing a range of sustainable-energy interventions. The thrust of this work focuses on the three major aspects of sustainable energy: energy efficiency improvements, renewable energy promotion and increased access by the poor to safe, modern, affordable energy. The Cape Town *State of Energy* 2015 report presents the energy picture of the city (2012 baseline) and tracks key sustainable energy indicators.

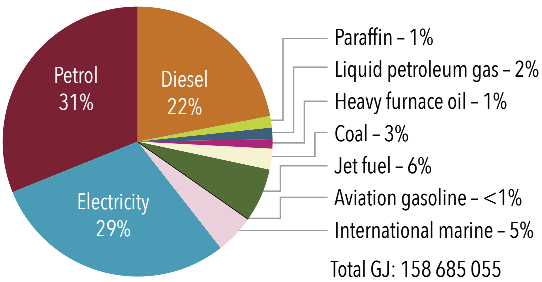
In terms of electricity, apart from a very small contribution of wind energy and rooftop photovoltaic, Cape Town mirrors the national mix.

The energy picture

Total final energy consumption in Cape Town for 2012 was 158 685 055 GJ (including electricity distribution losses).[1] This translates into a global greenhouse gas emissions equivalent of 21 282 238 tCO_2e, or 5,5 tCO_2e per capita. Energy sources in the city are dominated by petrol (31%), electricity (29%) and diesel (22%). Cape Town's international airport and port utilise jet fuel (6% of total energy) and marine fuel (5%). The remaining energy sources comprise coal (3%), liquid petroleum gas (2%) as well as paraffin and heavy furnace oil (1% each). Transport substantially dominates consumption (64%), followed by commerce (13%), the residential sector (12%) and industry (8%). The City of Cape Town municipal consumption accounts for 1% of total energy consumption.

Figure 1: Energy consumption by energy source, Cape Town, 2012*

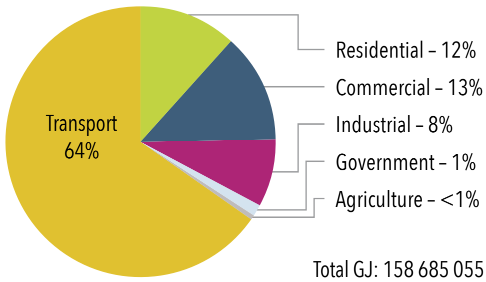
* Including aviation, international marine, electricity losses



Source: City of Cape Town, Eskom, Province, SAPIA.

Figure 2: Energy consumption by sector, Cape Town, 2012*

* Including aviation, international marine; excluding electricity losses



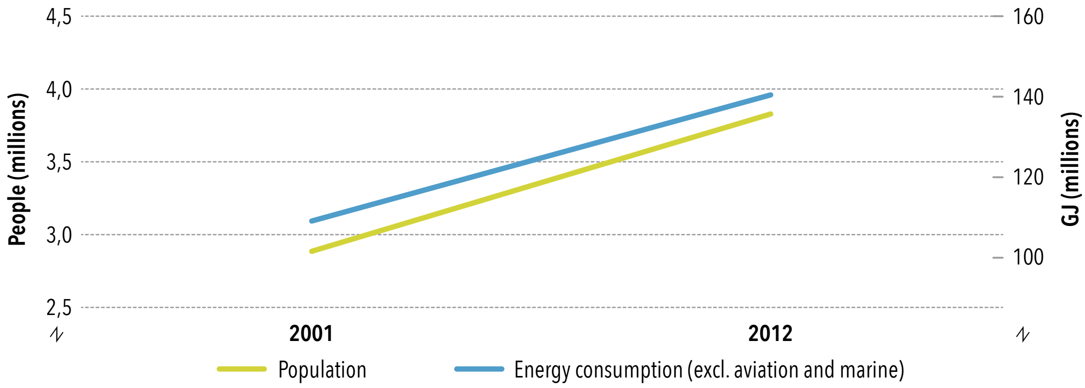
Source: City of Cape Town, Eskom, Province, SAPIA.

Total energy consumption in Cape Town grew by 26,8% between 2001 and 2012, and by 10,58% between 2007 and 2012.[2] The annual average growth rate between 2001 and 2012 was 2,18%. However, energy consumption growth was lower than both population growth (2,6% average annual increase) and economic growth (4% average annual growth) in the city over this period.

All liquid fuel in Cape Town is derived from oil imports. In terms of electricity, apart from a very small contribution of wind energy from Darling Wind Farm and rooftop photovoltaic (PV) (still nowhere near a visible proportion of total supply), Cape Town mirrors the national mix. Eskom generates 95% of the power in South Africa, of which 91% is coal-based and 4% is nuclear. Renewable-energy generation through the Independent Power Producers Programme contributes 1 915 MW of capacity – now accounting for around 5% of capacity (although, given capacity factors of renewable energy, actual power supplied to the grid will be lower). Another 1 512 MW have reached commercial operation and will shortly be added to the grid.

1. Total energy consumed, excluding electricity lost through technical and non-technical losses, is 154 893 032 GJ.
2. These figures have been calculated excluding international marine and aviation fuels, as data were not available in 2001 and untrustworthy in 2007.

Figure 3: Energy and population growth in Cape Town, 2001–2012



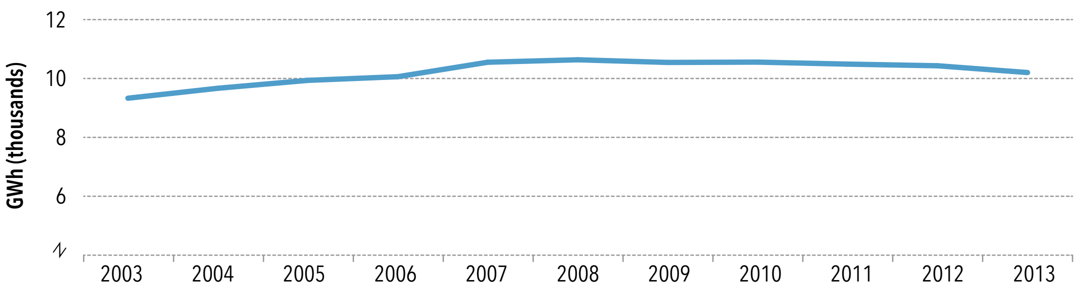
Source: City of Cape Town, DoE, Eskom, SAPIA, SEA, StatsSA.

Cape Town has experienced an absolute and unprecedented decline in electricity consumption in the period 2007–2012, particularly from the residential sector.

Electricity demand reduction

Although electricity consumption grew steadily up until 2007, Cape Town has experienced an absolute and unprecedented decline in electricity consumption in the period 2007–2012. Electricity demand reductions come particularly from the residential sector and, to a lesser extent, from the commercial sector. The demand reductions correspond to steep price increases experienced from 2008, electricity efficiency campaigns by Eskom as well as the City, the roll-out of prepayment metering systems and the global recession in 2009.

Figure 4: Bulk purchase of electricity by City of Cape Town Electricity Services Department, 2003–2013



Source: City of Cape Town Electricity Services Department.

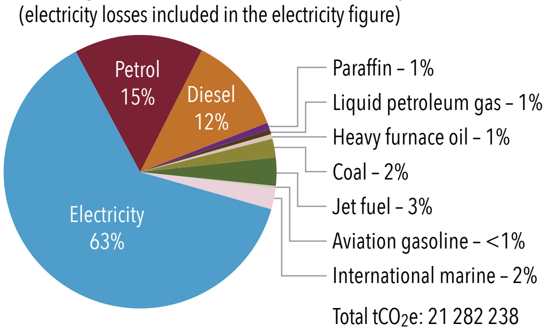
Global greenhouse gas emissions

Tracking global emissions over time is difficult, as data development in this area is still in its infancy: Since 2001, energy conversion factors have migrated from drawing on generic figures published by the International Energy Agency, to specific figures now published by our own national Department of Energy. Accepted and applicable emission factors have also changed and developed. This contributes to the lower emissions recorded in 2012 compared to 2007, despite a slightly higher energy consumption level.

Although emissions increased in absolute terms from 2001, emissions per capita (excluding marine and aviation fuel for comparative purposes) went from 5,7 tCO_2e in 2001 to 5,2 tCO_2e in 2012 (a 10% reduction), as the population increased

Figure 5: Carbon emissions by energy source, Cape Town, 2012*

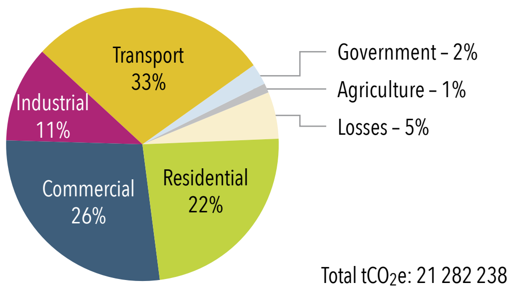
* Including aviation, international marine, electricity losses (electricity losses included in the electricity figure)



Source: City of Cape Town, Eskom, Province, SAPIA.

Figure 6: Carbon emissions by sector, Cape Town, 2012*

* Including aviation, international marine, electricity losses



Source: City of Cape Town, Eskom, Province, SAPIA.

more rapidly than energy consumption. This declining trend will have also been influenced by a decrease in electricity consumption. Electricity contributes disproportionately to emissions due to the high carbon content of our predominantly coal-based national electricity generation.

Household energy

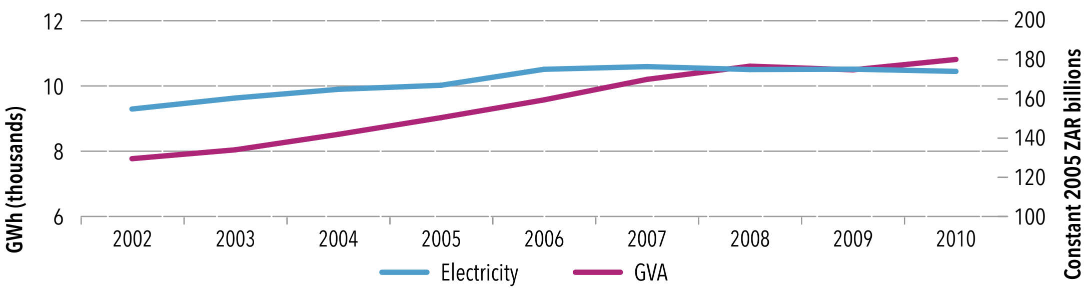
Low-income households in Cape Town comprise half of the city households (47%), but contribute only 24% to residential energy consumption. The vast majority of households in Cape Town are now electrified (94%) and electricity dominates household energy consumption across all income groups. Households contribute 37% to total city electricity consumption. As a sector, they play a significant role in shaping peak electricity demand in the city – particularly the high evening peak. A strong positive outcome of electrification, in line with national policy intentions, has been the decline in household paraffin consumption. Cape Town has a strong record amongst the metros in the country with regard to the electrification of informal areas and backyard dwellings, and is relatively effective in the delivery of the free basic electricity grant to poor households.

The vast majority of households in Cape Town are now electrified (94%) and electricity dominates household energy consumption across all income groups.

Commerce and industry

Cape Town's sector energy consumption reflects the city's economic composition, which is led by the tertiary sector (77% of economic value – and dominated by finance, insurance, real estate and business services), and has a relatively low industrial energy consumption. The ability of the city's economy to reduce electricity consumption while maintaining economic growth indicates a trend towards decoupling the economy from energy, i.e. producing economic value off reducing levels of energy input into the system. This is a positive economic indicator, although the associated impact on City revenue from electricity sales needs to be planned for.

Figure 7: City of Cape Town electricity demand trend relative to economic growth



Source: City of Cape Town Electricity Services Department, Quantec.

Transport sector

Continued energy growth in Cape Town, despite the absolute decline in electricity demand, has been driven by higher than business-as-usual levels of transport fuel consumption growth. This is driven predominantly by the growth in private passenger transport. Although less than half of the city's households own a car, private-car ownership in the city is increasing at a rate of 4% per annum (2009–2013). An astounding 91% of all liquid fuel relating to passenger transport is consumed by private cars, with an associated annual cost of R10–12 billion (ZAR in constant 2005 terms). This is a 'dead weight' cost both economically and socially: The money spent on fuel and vehicle costs that could have been available for local spending, and the burden of time spent commuting as congestion worsens. Public transport such as Metrorail, buses and minibuses, on the other hand, transports nearly half of all city passengers daily and consumes only 9% of all liquid fuel relating to passenger transport.

Continued energy growth in Cape Town, despite the absolute decline in electricity demand, has been driven by higher than business-as-usual levels of transport fuel consumption growth.

Institutional development and energy governance

The City of Cape Town has laid a strong institutional foundation for sustainable energy development, which it continues to promote. Over the period under review, an Energy and Climate Change Unit has been established and staffed, and strategies and action plans developed. The City's monitoring of its own energy consumption is now entrenched, with over 220 smart meters installed in City buildings and facilities (by 2015), and a range of energy efficiency projects and initiatives have been undertaken, including traffic and street-light retrofits, energy efficient building retrofits and training of building managers, the establishment of a commercial energy efficiency forum, and energy efficiency behaviour and efficient water-heating campaigns.

Renewable independent power production is a national growth area. In Cape Town, the City has begun to introduce rooftop PV installations on some of its own buildings in order to offset electricity consumption. In this way, the City is leading by example and also gaining hands-on experience of the practicalities relating to small-scale embedded generation systems. The City has also finalised the necessary institutional procedures and tariffs to accommodate small-scale embedded generation installations by city residents and businesses. New policy commitments within the City are aimed at developing larger-scale embedded generation and alternative energy sources, such as gas.

World view: *Composite world map showing Suomi NNP (National Polar-orbiting Partnership) satellite observations of night-time illumination.*
Source: NASA Earth Observatory/NOAA NGDC

2 ENERGY **DATA SHEETS**

The following section is an overview of relevant Cape Town energy data and sustainable energy indicators.

2.1. CAPE TOWN ENERGY BALANCE 2012

Table 1: Energy balance, Cape Town, 2012: native units

Energy source and unit	Electricity (kWh)	Petrol (ℓ)	Diesel (ℓ)	Paraffin (ℓ)	Liquid petroleum gas (ℓ)
Electricity: national transmission grid	12 990 011 625	–	–	–	–
Electricity: independent power producers (CCT power purchase agreement)	7 770 000	–	–	–	–
Electricity: small-scale embedded generation	194 910	–	–	–	–
Liquid fuel distributors		1 433 710 154	917 373 532	58 546 275	91 201 615
Coal distributors					
Total supply	12 997 976 535	1 433 710 154	917 373 532	58 546 275	91 201 615
Total final consumption	11 944 636 650	1 433 710 154	917 373 532	58 546 275	91 201 615
Residential	4 464 862 191	–	–	45 010 339	22 800 404
Commerce and public services	5 267 913 440	–	–	9 181 466	22 800 404
Industry sector	1 551 113 664	–	–	4 345 684	45 600 808
Transport sector		1 427 713 377	907 374 043	–	–
Local government	449 477 809	5 996 777	9 999 489	–	–
Agriculture	211 269 546	–	–	8 786	
Losses	1 053 339 885	–	–	–	–
% losses	8%	0%	0%	0%	0%

Note: Electricity losses included for municipal distribution only; paraffin in agriculture may be used for non-energy purposes (e.g. fertilizer).

Table 2: Energy balance, Cape Town, 2012: gigajoules

Energy source and unit	Electricity	Petrol	Diesel	Paraffin	Liquid petroleum gas
Electricity: national transmission (Eskom)	46 764 042	–	–	–	–
Electricity: IPP (CCT power purchase agreement)	27 972	–	–	–	–
Electricitiy: SSEG	702	–	–	–	–
Liquid fuels	–	49 032 887	34 951 932	2 166 212	91 201 615
Coal	–	–	–	–	–
Total supply	46 792 716	49 032 887	34 951 932	2 166 212	91 201 615
Total final consumption	43 000 692	49 032 887	34 951 932	2 166 212	91 201 615
Residential	16 073 504	–	–	1 665 383	22 800 404
Commerce and public services	18 964 488	–	–	339 714	22 800 404
Industry sector	5 584 009	–	–	160 790	45 600 808
Transport sector	–	48 827 797	34 570 951	–	–
Local government	1 618 120	205 090	380 981	–	–
Agriculture	760 570	–	–	325	–
Conversion factor (GJ/unit)	0,0036	0,0342	0,0381	0.037	–
Original unit	kWh	ℓ	ℓ	ℓ	ℓ
Losses	3 792 024	–	–	–	–
% losses	8%	0%	0%	0%	0%

2.2 CAPE TOWN ENERGY AND EMISSIONS OVERVIEW TABLES

Table 3: Energy consumption and greenhouse gas-related emissions, Cape Town, 2001–2012

Energy source	2001		2007		2012	
	GJ	tCO_2e	GJ	tCO_2e	GJ	tCO_2e
Electricity	36 835 284	11 256 863	48 576 102	14 844 856	46 792 716	13 379 712
Coal	3 831 352	361 680	3 055 991	288 485	4 082 400	472 080
Petrol	40 687 369	2 815 566	39 392 694	2 725 974	49 032 887	3 264 558
Diesel	20 127 757	1 487 441	27 874 053	2 059 892	34 951 932	2 478 743
Paraffin	2 448 796	175 579	2 830 399	202 939	2 166 212	150 874
Liquid petroleum gas	684 970	43 153	1 750 168	110 260	2 435 083	147 929
Heavy furnace oil	4 695 842	362 519	4 116 143	317 766	1 633 921	116 574
Jet fuel	–	–	16 082 323	1 153 103	10 062 689	738 126
Aviation gasoline	–	–	–	–	30 371	1 975
International marine	–	–	38 237 320	2 990 158	7 496 844	531 666
Totals	**109 311 370**	**16 502 801**	**181 915 193**	**24 693 433**	**158 685 055**	**21 282 238**
Totals excluding aviation and marine	**111 311 370**	**16 502 801**	**127 595 550**	**20 550 172**	**141 095 151**	**20 010 470**

Note: Data for 2003 did not include international marine or aviation fuel figures. From 2009 onwards, emission factors were recalibrated, which resulted in a slight decrease in emissions figures.[3] Source: City of Cape Town, Eskom, SAPIA, Quantec, Cape Town State of Energy 2003, 2007.

3. Initial coefficients drew on international standards, but more locally appropriate coefficients have since been established.

Table 1 continued					
Heavy furnace oil (ℓ)	Coal (kg)	Jet fuel (ℓ)	Aviation gas (ℓ)	International marine (ℓ)	Data source
–	–	–	–	–	Eskom
–	–	–	–	–	City of Cape Town Electricity Services Department
–	–	–	–	–	SEA study
39 276 949	–	293 372 866	895 897	196 767 565	SAPIA
–	168 000 000	–	–	–	Coal suppliers
39 276 949	168 000 000	293 372 866	895 897	196 767 565	
39 276 949	168 000 000	293 372 866	895 897	196 767 565	
–	252 000	–	–	–	City of Cape Town, Eskom, SAPIA
3 129 463	13 050	–	–	–	City of Cape Town, Eskom, SAPIA, Province
36 147 486	167 734 950	–	–	–	City of Cape Town, Eskom, SAPIA
–	–	293 372 866	895 897	196 767 565	City of Cape Town, Eskom, SAPIA
–	–	–	–	–	City of Cape Town, Eskom, SAPIA
–	–	–		–	City of Cape Town, Eskom, SAPIA
–	–	–	–	–	
0%	0%	0%	0%	0%	

Table 2 continued					
Heavy furnace oil	Coal	Jet fuel	Aviation gas	International marine	Total
–	–	–	–	–	46 764 042
–	–	–	–	–	27 972
–	–	–	–	–	702
1 633 921	–	10 062 689	30 371	7 496 844	107 809 940
–	4 082 400	–	–	–	4 082 400
1 633 921	4 082 400	10 062 689	30 371	7 496 844	158 685 055
1 633 921	4 082 400	10 062 689	30 371	7 496 844	154 893 032
–	6 124	–	–	–	18 353 781
130 186	317	–	–	–	20 043 476
1 503 735	4 075 959	–	–	–	12 542 036
–	–	10 062 689	30 371	7 496 844	100 988 653
–	–	–	–	–	2 204 190
–	–	–	–	–	760 895
0,0416	0,0243	0,0343	0,0339	0,0381	N/A
ℓ	kg	ℓ	ℓ	ℓ	N/A
–	–	–	–	–	3 792 024
0%	0%	0%	0%	0%	2%

Table 4: Energy demand (GJ) by energy type and sector, Cape Town, 2012

Fuel	Residential	Commercial	Industrial	Transport	Government	Agriculture	Elec losses	Total	% Total
Electricity	16 073 504	18 964 488	5 584 009	–	1 618 120	760 570	3 792 024	46 792 716	29%
Petrol	–	–	–	48 827 797	205 090	–	–	49 032 887	31%
Diesel	–	–	–	34 570 951	380 981	–	–	34 951 932	22%
Paraffin	1 665 383	339 714	160 790	–	–	325	–	2 166 212	1%
Liquid petroleum gas	608 771	608 771	1 217 542	–	–	–	–	2 435 083	2%
Heavy furnace oil	–	130 186	1 503 735	–	–	–	–	1 633 921	1%
Coal	6 124	317	4 075 959	–	–	–	–	4 082 400	3%
Natural gas	–	–	–	–	–	–	–	0–	0%
Jet fuel	–	–	–	10 062 689	–	–	–	10 062 689	6%
Aviation gasoline	–	–	–	30 371	–	–	–	30 371	0%
International marine	–	–	–	7 496 844	–	–	–	7 496 844	5%
Total	**18 353 781**	**20 043 476**	**12 542 036**	**100 988 653**	**2 204 190**	**760 895**	**-**	**158 685 055**	**-**
% of total	**12%**	**13%**	**8%**	**64%**	**1%**	**0%**	**2%**	**-**	**-**

Cape Town energy and emissions overview tables continued.

Table 5: Energy-related GHG emissions by energy source and sector (tCO_2e), Cape Town, 2012

Fuel	Residential	Commercial	Industrial	Transport	Government	Agriculture	Elec losses	Total	% Total
Electricity	4 598 808	5 417 747	1 597 647	–	462 962	217 608	1 084 940	13 379 712	63%
Petrol	–	–	–	3 250 903	13 655	–	–	3 264 558	15%
Diesel	–	–	–	2 451 725	27 019	–	–	2 478 743	12%
Paraffin	115 992	23 661	11 199	–	–	23	–	150 874	1%
Liquid petroleum gas	36 982	36 982	73 965	–	–	–	–	147 929	1%
Heavy furnace oil	–	9 288	107 286	–	–	–	–	116 574	1%
Coal	708	37	471 335	–	–	–	–	472 080	2%
Natural gas	–	–	–	–	–	–	–	–	0%
Jet fuel	–	–	–	738 126	–	–	–	738 126	3%
Aviation gasoline	–	–	–	1 975	–	–	–	1 975	0%
International marine	–	–	–	531 666	–	–	–	531 666	2%
Total	**4 752 490**	**5 487 715**	**2 261 431**	**6 974 396**	**503 635**	**217 630**	–	**21 282 238**	–
% of total	22%	26%	11%	33%	2%	1%	5%	100%	–

Table 6: Energy consumption for Cape Town, Western Cape and South Africa, 2012

Fuel	Cape Town			Western Cape			National		
	Native unit	GJ	CO_2	Native unit	GJ	CO_2	Native unit	GJ	CO_2
Electricity (kWh)	12 997 976 535	46 792 716	13 379 712	22 975 000 000	82 710 000	23 664 250	217 418 000 000	782 704 800	223 940 540
Coal (kg)	168 000 000	4 082 400	472 080	2 406 038 355	72 421 754	6 760 968	21 033 457 974	511 113 029	59 104 017
Petrol (ℓ)	1 433 710 154	49 032 887	3 264 558	1 723 202 680	58 933 532	3 923 733	11 733 080 659	401 271 359	26 716 225
Diesel (ℓ)	917 373 532	34 951 932	2 478 743	1 324 781 136	50 474 161	3 579 559	11 228 716 399	427 814 095	30 339 992
Paraffin (ℓ)	58 546 275	2 166 212	150 874	73 392 328	2 715 516	189 132	530 890 233	19 642 939	1 368 104
Liquid petroleum gas (ℓ)	91 201 615	2 435 083	147 929	182 820 880	4 881 317	296 535	644 524 503	17 208 804	1 045 419
Natural gas (ℓ)	–	–	–	2 106	86	–	1 959 078 167	80 322 205	3 944
Heavy furnace oil (ℓ)	39 276 949	1 633 921	116 574	114 578 343	4 766 459	340 069	523 157 603	21 763 356	1 552 732
Jet fuel (ℓ)	293 372 866	10 062 689	738 126	438 980 237	15 057 022	1 104 474	2 379 701 245	81 623 753	5 987 328
Aviation gas (ℓ)	895 897	30 371	1 975	2 114 382	71 678	4 662	31 477 290	1 067 080	69 407
International marine (ℓ)	196 767 565	7 496 844	531 666	94 495 312	3 600 271	255 326	–	–	–
Total		**158 685 055**	**21 282 238**	–	**295 631 798**	**40 118 708**	–	**2 344 531 419**	**350 127 707**

Source: City of Cape Town, Eskom, SAPIA, Western Cape Energy and Emissions Database Report (2012), National Energy Balance (DoE, 2009). Values are as close to the 2012 baseline as possible.

2.3 CAPE TOWN SUSTAINABLE ENERGY INDICATORS

The Cape Town energy indicators present an overview of key statistics relating to common global indicators of the transition to sustainable energy.

Table 7: Energy indicators, Cape Town, 2001–2012

Population	**2001**	**2007**	**2012**
Cape Town population	2 892 243	3 374 572	3 837 414
Total number of households	759 485	932 159	1 068 573
Average household size	3,81	3,62	3,59
Population density (persons per km^2)	1 178	1 375	1 563
Economy and socio-economic factors	**2001**	**2007**	**2012**
Unemployment rates	29,2%	No data	23,9%
Human Development Index	71%	73%	74%
Poverty (% households earning <R3 200/month)	24%	20%	20%
Cape Town gross value added (GVA) (constant 2005 ZAR millions)	124 928	169 998	185 682
Energy and emissions	**2001**	**2007**	**2012**
Total energy consumption (GJ)	–	181 915 193	158 685 055
Total energy consumption (excluding international marine and aviation) (GJ)	109 311 370	127 595 550	141 095 151
Total energy-related GHG emissions (tCO_2e)	–	24 693 433	21 282 238
Total energy-related GHG emissions (excluding international marine and aviation) (tCO_2e)	16 502 801	20 550 175	20 010 470
Energy consumption per capita (excluding international marine and aviation) (GJ/capita)	37,8	37,8	36,8
GHG emissions per capita (energy only, all fuels) (tCO_2e/capita)	–	7,32	5,55
GHG emissions per capita (energy only, excluding international marine and aviation) (tCO_2e/capita)	5,71	6,09	5,21
GHG emissions per capita (all energy and waste) (tCO_2e/capita)	No data	7,82	6,01
Energy intensity excluding international marine and aviation (GJ/GVA)	875	751	760
Energy intensity excluding international marine and aviation (GVA/GJ)	0,0011	0,0013	0,0013
Electricity-system maximum demand (MW)	1 616	1 880	1 919
Renewable energy (small-scale embedded generation or power purchased) (kWh)	–	–	7 964 910
Renewable energy as share of total electricity distributed (%)	–	–	0,001%
Municipal energy consumption in facilities and operations	**2001**	**2007**	**2012**
Energy (GJ)	1 736 741	1 808 497	1 917 835
Energy-related GHG emissions (tCO_2e)	264 342	414 502	421 706
Electricity (kWh)	183 814 634	266 322 660	375 223 313
Petrol and diesel (ℓ)	29 060 686	12 989 349	15 996 267
Waste	**2001**	**2007**	**2012**
Waste generated (tonnes)	No data	2 963 241	2 001 248
Waste minimised (%)	No data	6%	12%
Waste per capita (tonnes/capita)	No data	0,9	0,5
Household energy and energy poverty	**2001**	**2007**	**2012**
Solar water heater installations (SWHs)	**2001**	**2007**	**2014**
High-pressure SWHs installed (based on municipal geographic information systems exercise)	–	–	25 000
Low-pressure SWHs installed	–	–	4 510
Electrified households (lighting as proxy)	89%	No data	94%
Households using 'clean and safe' fuels for cooking	83%	No data	95%
Households receiving free basic electricity (FBE)	No data	No data	320 000
Maximum possible share of indigent households accessing FBE (households receiving FBE ÷ households earning <R3 200)	No data	No data	64%
Transport and mobility	**2001**	**2007**	**2012**
Non-motorised transport (NMT) as portion of all work trips	No data	15%	16%
Private-vehicle transport as portion of all work trips	No data	No data	42%
Public-vehicle transport as portion of all motorised work trips	47%	51%	46%
Share of households that own one or more cars (%)	No data	No data	46%
Number of light passenger vehicles	No data	No data	794 796

Note: International marine and aviation fuel figures are not reliable and were also not included in the 2003 State of Energy report (2001 baseline year). Therefore, a number of indices have been calculated excluding these figures. For purposes of reporting 2012 figures, the full energy totals, with all energy sources included, should be used.

2.4 GLOBAL GREENHOUSE GAS EMISSIONS

This account is based on the Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC) reporting method. The United Nations Framework Convention on Climate Change (UNFCCC) has adopted the GPC as its official climate reporting standard for cities. Emission factors draw on those of the Intergovernmental Panel on Climate Change (IPCC) for South Africa (web-based and regularly updated) as well as Eskom for local electricity emission factors. This account reports only those emissions associated with energy consumption and waste, and should therefore be regarded as a BASIC GPC report, not including land use change and indirect emissions through consumption of goods. Scope 3 emissions record only those emissions relating to electricity transmission losses and waterborne navigation.

Local-level reporting protocols dictate consumption as the basis for emissions accountability. This means that even if the emissions take place outside the municipal boundary, if they relate to energy consumption within this boundary, they are accounted for within Cape Town's GHG inventory. Thus, local-level inventories take into account the emission factor relating to the national supply 'mix' of electricity in the country.

Section 3.5 contains more information on the GPC.

In table 8, scope 1 includes all emissions that physically take place within the Cape Town area. These include liquid fuels consumed, as well as coal. As explained above, even if the liquid fuel is moved out of the City of Cape Town area (in a vehicle or boat), it is still accounted for as per the point of sale. This scope also includes the emissions from Ankerlig and Acacia power stations, although these are removed from the final balance for Cape Town (and accounted for within Eskom's national electricity production accounts) as per the GPC requirements. Scope 2 includes emissions from electricity produced elsewhere in the country but consumed in Cape Town. Although the scope 2 column accounts for the majority of these emissions, a small portion is also recorded under scope 3, reflecting that component of the emission factor that relates to transmission and distribution (i.e. from power station to municipal boundary, amounting to 0,04 of the 1,03 emission factor). The category "Energy industries" also includes municipal distribution losses.

Table 8: Global Protocol for Community-Scale Greenhouse Gas (GHG) Emission Inventories (GPC): Summary table - BASIC

Name of city: Cape Town, South Africa Boundary: Administrative boundary of a local government Inventory year: 1 January 2012 – 31 December 2012		Population: 3 837 414 Land area (km²): 2 455 GDP (US$ bn): 17,45				
GHG emissions source (by sector)		**Total GHGs (metric tonnes CO_2e)**				
		Scope 1	**Scope 2**	**Scope 3**	**BASIC**	**BASIC+**
Stationary energy	Energy use (all emissions except I.4.4)	887 598	12 757 959	515 473	13 645 416	14 160 889
	Energy generation supplied to the grid (I.4.4)	724 052	–	–	–	–
Transportation	(all II emissions)	5 743 301	102 152	1 275 895	5 845 454	7 121 348
Waste	Waste generated in the city (III.X.1 and III.X.2)	2 423 892	–	–	2 423 892	2 423 892
	Waste generated outside city (III.X.3)	–	–	–	–	–
Industrial processes and product use (IPPU)	(all IV emissions)	–	–	–	–	–
Agriculture, forestry and land use (AFOLU)	(all V emissions)	–	–	–	–	–
Other scope 3	(all VI emissions)	–	–	–	–	–
Total		**9 778 702**	**12 860 112**	**1 791 368**	**21 914 762**	**23 706 130**

GPC ref no.	**GHG emissions source (by sector and sub-sector**	**Total GHGs (metric tonnes CO_2e)**			
		Scope 1	**Scope 2**	**Scope 3**	**Total**
I	**Stationary energy**				
I.1	Residential buildings	153 682	4 420 214	178 594	4 752 490
I.2	Commercial and institutional buildings and facilities	69 986	5 652 332	228 377	5 590 677
I.3	Manufacturing industries and construction	663 784	1 433 450	57 917	2 155 152
I.4.1/2/3	Energy industries	IE	IE	IE	–
I.4.4	Energy generation supplied to the grid	724 052	–	–	–
I.5	Agriculture, forestry and fishing activities	23	209 157	8 451	217 630
I.6	Non-specified sources	NO	1 042 806	42 134	1 084 940
I.7	Fugitive emissions from mining, processing, storage and transportation of coal	NO	–	–	–
I.8	Fugitive emissions from oil and natural gas systems	NO	–	–	–
Sub-total	**(city induced framework only)**	**887 457**	**12 757 959**	**515 473**	**14 160 889**
II	**Transportation**				
II.1	On-road transportation	5 743 301	NO	NE	5 743 301
II.2	Railways	NO	102 152	4 127	106 280
II.3	Waterborne navigation	IE	NO	531 666	531 666
II.4	Aviation	IE	NO	740 102	740 102
II.5	Off-road transportation	IE	NO	NE	–
Sub-total	**(city induced framework only)**	**5 743 301**	**102 152**	**1 275 895**	**7 121 348**

Table 8 continued

GPC ref no.	GHG emissions source (by sector and sub-sector)	Total GHGs (metric tonnes CO_2e)			
		Scope 1	Scope 2	Scope 3	Total
III	**Waste**				
III.1.1/2	Solid waste generated in the city	2 286 195	–	NO	2 286 195
III.2.1/2	Biological waste generated in the city	NO	–	NO	–
III.3.1/2	Incinerated and burned waste generated in the city	NO	–	NO	–
III.4.1/2	Wastewater generated in the city	137 697	–	NO	137 697
III.1.3	Solid waste generated outside the city	IE	–	–	–
III.2.3	Biological waste generated outside the city	NO	–	–	–
III.3.3	Incinerated and burned waste generated outside the city	NO	–	–	–
III.4.3	Wastewater generated outside the city	IE	–	–	–
Sub-total	**(city induced framework only)**	**2 423 892**	–	–	**2 423 892**
IV	**Industrial processes and product uses**				
IV.1	Emissions from industrial processes occurring in the city boundary	NE	–	–	–
IV.2	Emissions from product use occurring within the city boundary	NE	–	–	–
Sub-total	**(city induced framework only)**	–	–	–	–
V	**Agriculture, forestry and other land use**				
V.1	Emissions from livestock	NE	–	–	–
V.2	Emissions from land	NE	–	–	–
V.3	Emissions from aggregate sources and non-CO2 emission sources on land	NE	–	–	–
Sub-total	**(city induced framework only)**	–	–	–	–
VI	**Other scope 3**				
VI.1	Other scope 3	–	–	NE	–
Total	**(city induced framework only)**	**9 054 650**	**12 860 112**	**1 791 368**	**23 706 130**
Total	**Cape Town energy-related emissions (BASIC+ total minus waste)**	–	–	–	**21 282 238**

Note: NO – not occurring, IE – included elsewhere, NE – not estimated. Minor differences in totals between the GPC inventory and total emissions reported elsewhere in the 2015 State of Energy *report are due to minor changes in emission factors, converting between different units and rounding.*

2.5 LOCAL AIR POLLUTION FROM ENERGY SOURCES

Table 9: Local air pollution

Residential	**ℓ/kg**	**Units**	**SO_2**	**NO_x**	**VOCs**	**PM^{10}**	**$PM^{2,5}$**
Paraffin	45 010 339	g/ℓ	382 587 882	67 515 509	9 002 068	9 002 068	9 002 068
LPG (converted into kg)	12 173 136	g/kg	–	–	–	–	–
Coal	252 000	g/kg	4 788 000	378 000	1 260 000	1 033 200	413 280
Commerce and industry	**ℓ/kg**	**Units**	**SO_2**	**NO_x**	**VOCs**	**PM^{10}**	**$PM^{2,5}$**
Coal	167 748 000	g/kg	3 187 212 000	251 622 000	838 740 000	687 766 800	275 106 720
Paraffin	13 527 150	g/ℓ	114 980 775	20 290 725	1 217 444	2 705 430	2 705 430
LPG (converted into kg)	36 519 407	g/kg	228 004	31 920 565	11 400 202	1 596 028	1 596 028
Transport	**ℓ**	**Units**	**SO_2**	**NO_x**	**VOCs**	**PM^{10}**	**$PM^{2,5}$**
Petrol vehicles	1 427 713 377	g/ℓ	2 427 112 741	25 698 840 786	51 397 681 572	856 628 026	713 856 689
Diesel vehicles	907 374 043	g/ℓ	8 438 578 600	5 534 981 662	4 536 870 215	5 988 668 684	5 534 981 662
Power sector*	**ℓ/kg**	**Units**	**SO_2**	**NO_x**	**VOCs**	**PM^{10}**	**$PM^{2,5}$**
Ankerlig: diesel	267 322 211	g/ℓ	1 662 744 155	24 994 626 772	–	1 791 058 817	–
Acacia: jet kerosene	2 694 100	g/ℓ	16 757 301	251 989 341	–	18 050 469	–
Eskom figures Ankerlig: diesel	267 322 211	g/ℓ	224 640 514	1 054 300 000	–	–	–
Eskom figures Acacia: jet kerosene	2 694 100	g/ℓ	4 256 082	–	–	–	–

Note: Emission factors for residential, commerce, industry and transport courtesy of the Air Quality Department, City of Cape Town. Two sets of emission figures are provided for the power sector – one set using Air Quality Department emission factors (noted as being subject to high uncertainty), the other using figures published by Eskom.[4]

Transport fuels account for a sizeable contribution to local air pollution. Until recently, minimal electricity was produced within Cape Town and, thus, it contributed very little to local air pollution. However, with the current national power crisis, Eskom is running two diesel-fuelled 'peaking' stations[5] at very high output levels in the city. Air-quality-related figures presented for the Eskom power stations are limited. Indoor air pollution relating to paraffin use is a concern. Finally, coal has a notable impact on local air pollution relative to its proportion of total energy consumed.

4. http://www.eskom.co.za/OurCompany/SustainableDevelopment/Pages/CDM_Calculations.aspx.
5. Also called 'peaker plants' or 'peakers'. Power plants that generally run only when there is high demand for electricity.

2.6 CAPE TOWN LAND USE AND POPULATION DENSITY

Figure 8: Population density per hectare, Cape Town, 2001 and 2011

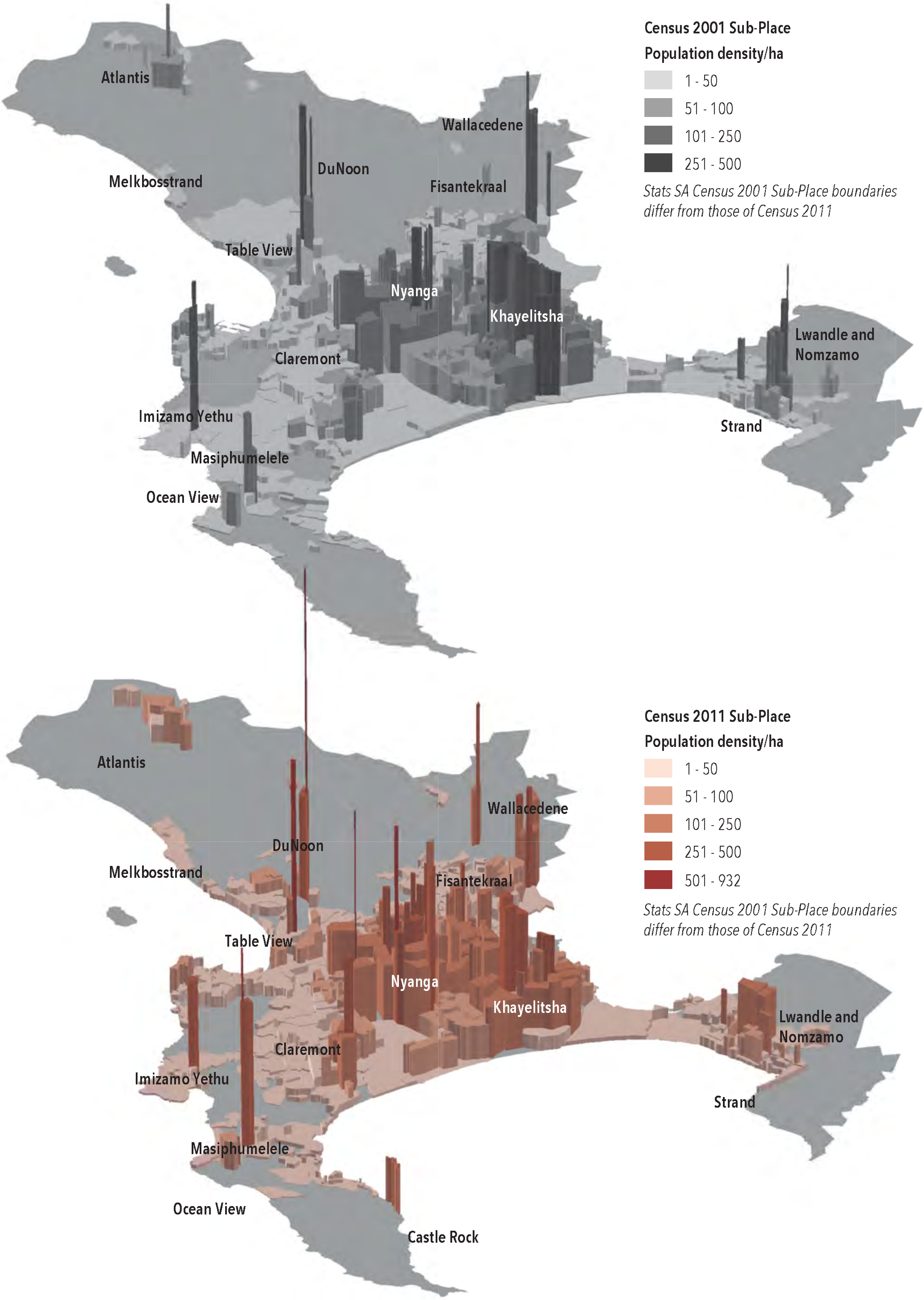
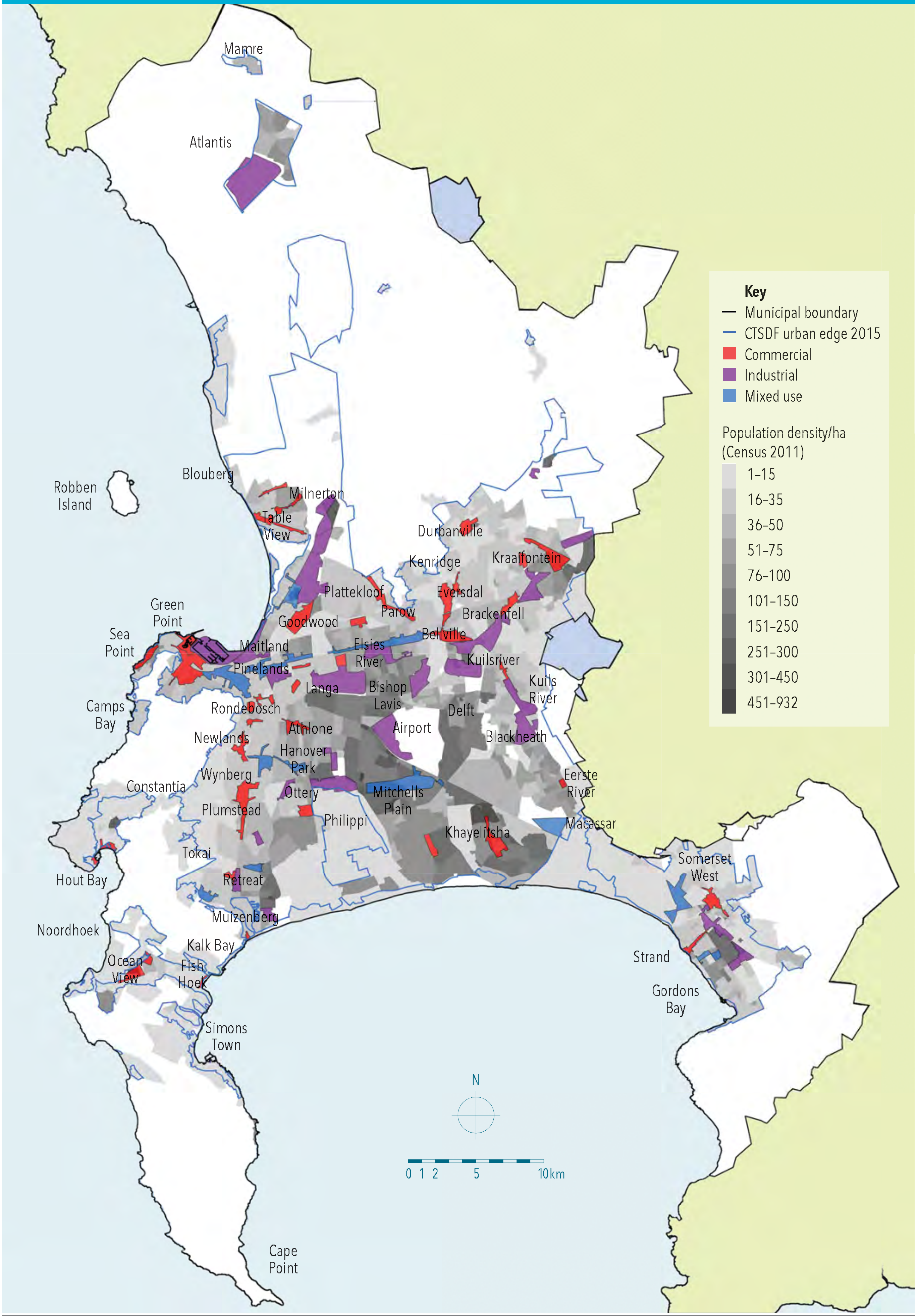


Figure 9: Land use and population density per hectare, Cape Town, 2011



3 INTRODUCTION AND BACKGROUND

The world is entering a new era of energy development, and the need to understand and be able to respond proactively to the rapidly changing environment is clear. To achieve this, a sound data collection and collation system is vital.

The Cape Town *State of Energy* report provides the background information to guide the City of Cape Town's strategy development in relation to energy and development in Cape Town. The data-gathering exercise is also a means to monitor progress towards existing targets and to support the redefinition of goals and targets going forward. Solid local energy consumption data also constitute an important part of the total national energy and emissions picture. Increasingly, global cities such as Cape Town are expected to report on international platforms with regard to their greenhouse gas emissions status. In this context, a strong database is critical.

This third iteration of Cape Town's *State of Energy* report (building on those released in 2003 and 2009, respectively using 2001 and 2007 as data baselines) reflects the City's prioritisation of energy work, with improved internal capacity and greater resources to produce quality data from both internal and external sources. With respect to local-level energy data, the City of Cape Town has the longest record in the country and can now start to detect and analyse trends. In many instances, however, the greater volumes and detail of data also indicate where possible data challenges are still experienced. The section "Method notes" at the end of the report provides a detailed account of data sources and where sizeable data challenges persist.

The world, the country and cities are entering a new era with regard to energy development. Changes over the past ten years have been sizeable and the future is uncertain. Climate change means that we must find radical alternatives to the current pattern of high-carbon development. South Africa has led one of the fastest-growing renewable energy programmes in the world. However, the country is still constrained in terms of electricity supply capacity and is pulling in two directions: While nuclear energy supply deals seem to have been brokered, policy and planning such as the National Development Plan (NDP) and the Integrated Resources Plan (IRP 2010) point to a more modular, smaller-scale and diverse electricity supply industry able to respond to actual demand as it arises. At the level of demand, electricity prices have increased steeply and electricity demand has declined. The economy and the poor, who increasingly depend on electricity as their major source of household energy, are very vulnerable to price increases. Demand has now outstripped supply and the country has initiated loadshedding.

It is also increasingly clear that urban form, public transport provision and freight management heavily affect the transport fuels required to ensure residents' mobility as well as commercial activity. High demand for transport fuels renders the city vulnerable to oil price increases and represents a sizeable economic cost to Cape Town. Oil price increases, in addition to demand increases, doubled the city's transport fuel bill between 2010 and 2012.[6] Transport fuels are burnt at the point of consumption (whereas electricity may be imported), and therefore have a direct impact on the levels of local air pollution in and the 'liveability' of a city.

High demand for transport fuels renders the city vulnerable to oil price increases and represents a sizeable economic cost to Cape Town. Oil price increases, in addition to demand increases, doubled the city's transport fuel bill between 2010 and 2012. Transport fuels are burnt at the point of consumption and therefore have a direct impact on the levels of local air pollution.

Against this background, the need to understand and be able to respond proactively to the rapidly changing environment is clear. To achieve this, a sound data collection and collation system is vital. The process of generating the Cape Town *State of Energy* report is in itself an important opportunity to engage City departments and external stakeholders in understanding the relevance of the local energy picture and how it affects the various service sectors. As such, the development of this report has laid strong foundations for a more systematic energy data collection process within the City.

3.1 REPORT OVERVIEW, METHOD AND DATA SOURCES

Being the third update of Cape Town's energy data, the Cape Town *State of Energy* 2015 report provides an opportunity to begin to track changes over time. However, this is done with a note of caution: Despite every attempt to be thorough and consistent, data collection and collation remains an imprecise science. Although electricity demand data are now very thorough, the allocation of customers to different tariff categories has changed over the past years;[7] liquid fuel data from SAPIA/DoE, when analysed over time, show a high degree of variability, while the sourcing of coal data has also changed over the years.

The study area is the municipal area of Cape Town. Local energy strategies recognise energy demand – the where and how

6. See Figure 19: "Total cost of petrol and diesel consumption, Cape Town, 2007–2012."
7. Work is under way to develop an analysis of customers based on rates rather than tariff categories, but this was not yet feasible within this study.

Cape Town is a 'taker' of the national electricity mix, except where it independently purchases directly from another power supplier. So, even if Cape Town effectively receives most of its power from Koeberg, its electricity-related emissions will still reflect the national mix, as Koeberg is a national power station.

of energy consumption – as the basis for managing local energy and meeting citizens' energy service needs. Therefore, the report starts with an in-depth examination of energy demand in Cape Town. The analysis disaggregates the city into five sectors, namely residential, commerce, industry and transport. It then examines how this demand for energy is met, i.e. the energy supply-side picture. Interestingly, new areas of sustainable energy development, such as energy efficiency and small-scale embedded generation, are starting to blur the distinction between traditional energy demand and energy supply balances.

Consumption of energy is allocated to the city and the sectors according to a global standard that has been developed over time and is now captured in the Global Protocol for Community-Scale Greenhouse Gas Emission Reporting (GPC) (see section 3.5). Key points to be kept in mind regarding local-scale energy data reporting include the following:

a. All fuels sold in a local area are reported within that area, even if they are physically consumed elsewhere, for example when a car/ship/aeroplane refuels in Cape Town, but then journeys out of the city.
b. The city is a 'taker' of the national electricity mix, except where it independently purchases directly from another power supplier. So, even if Cape Town effectively receives most of its power from Koeberg, its electricity-related emissions will still reflect the national mix.
c. In line with the above, carbon emissions are counted at the point of consumption. Scope allocations, indicating whether the emission takes place directly in that area or is indirect, prevent double accounting.

The transport sector is substantial and involves particular dynamics that require a consolidated focus. For this reason, this report assigns all transport-related energy consumption to a transport sector rather than to the respective sectors mentioned above, e.g. residential for passenger transport, commercial for freight, etc. As the data improve, it will become increasingly possible to allocate transport to different sectors and different modes, deepening the understanding of demand. In addition, a growing understanding of the link between spatial form and energy may add a new dimension to future *State of Energy* reports.

A method note at the end of this document provides a detailed overview of data sources. In brief, however, the major sources are as follows:

On the demand side:

1. **The City of Cape Town**, predominantly the Systems Application Product (SAP) sales data information sourced from the Electricity Services Department; the Environmental Resource Management Department (ERMD) and other relevant City departments for the City's 'own' electricity consumption; Transport for Cape Town (TCT) for transport data; the City's Strategic Information and GIS Department for demographic and transport-related data, and Air Quality for coal data referencing.
2. **Statistics South Africa's Census 2001 and 2011** as well as **General Household Survey 2012** for demographic and energy data relating to Cape Town households.[8]
3. **Quantec** for economic data, which the City's Economic Development Department also uses, thus ensuring alignment.

On the supply side:

4. **Eskom** for electricity directly distributed from Eskom to its customers within the municipal boundaries.

8. The analysis in this report uses Stats SA population growth figures for Cape Town. However, the population growth reflected in the transport figures on population and car ownership draws on figures of the City's Strategic Information and GIS Department, which are slightly different.

5. **National Department of Energy** (DoE) for the South African Petroleum Industry Association (SAPIA) liquid fuel data and national energy balance data.
6. **Chevron South Africa** for international marine figures.

Electricity consumption data are very comprehensive and reliable, but challenges remain in disaggregating the data down to end-use application per sector. Work is under way towards a greater disaggregation down to customer and spatial level. It is anticipated that the data could be analysed through the rates allocations on the SAP system, thus enabling a distinction between residential, commercial or industrial electricity consumers. The reliability of the DoE/SAPIA liquid fuel data, particularly when analysed over time, is not very clear. Coal data are also difficult to collect on any consistent basis.

As far as possible, data have been gathered based on the 2012 calendar year. Exceptions to this are noted and explained in the detailed method note. For purposes of comparison over time, rand values are expressed in 2005 terms. The gross value added (GVA) for Cape Town is presented in 2011 terms, as Quantec data for 2012 were not available.

3.2 SYSTEMATISING THE ENERGY DATA COLLECTION PROCESS

The *State of Energy* update included a process to ensure that data are systematised and standardised in the City. Energy data management methods have been refined and simplified, and relevant staff capacity built. Energy data have been aligned with the City's economic data. Exploratory discussions were also held with City staff about potentially spatialising energy data and aligning this information with the economic spatial data development currently under way. In addition, discussions were held with Province to explore potential data collaboration relating to enhanced economic and energy future scenario development.

The City has made enormous strides, particularly in terms of internal energy consumption data collection and collation. This is led by ERMD's Energy and Climate Change Unit and is increasingly supported and assisted by the line departments. To aid this, real-time metering has been put in place in a number of municipal buildings and facilities.

DataFirst, a data curator organisation associated with the University of Cape Town, has been engaged in the data collection systematisation process. It is anticipated that, as part of the City's ongoing open data approach, more and more energy data will be available to researchers for greater depth of analysis over time.

Challenges to the systematic collection of energy data include both internal aspects (over which the City has a degree of control, though the challenges are not always easy to resolve) and external data (over which the City has very little control). These challenges include the following:

a. Data on direct Eskom electricity distribution (accounting for a quarter of the electricity consumed in Cape Town) can only be obtained via a confidentiality agreement, which is currently cumbersome for the City to engage in.
b. The municipal SAP electricity data lack codes to indicate to which sector the consumer belongs. Indications are that this could be solved through sorting via the rates allocation, but this still needs to be done.
c. DoE/SAPIA liquid fuel data require adjustment from magisterial to municipal boundaries; sector allocations are not entirely clear, and the figures, particularly for marine fuel, show a high degree of variation over years.

Despite these challenges, progress has been made towards establishing a systematic data collection process and institutionalising this capacity in the City. The foundations have also been laid for greater collaboration with Province and DataFirst, whose platform would give Cape Town's data a global research 'reach'.

The City has made enormous strides, particularly in terms of internal energy consumption data collection and collation. This is led by ERMD's Energy and Climate Change Unit and is increasingly supported and assisted by the line departments. To aid this, real-time metering has been put into place in a number of municipal buildings and facilities.

The next 'frontier' of Cape Town's *State of Energy* will be a better understanding of the spatial energy characteristics of the city would enable more targeted, locally appropriate strategies.

3.3. 'SPATIALISING' CAPE TOWN ENERGY DATA

Cape Town's 2003 *State of Energy* report represented a first pioneering effort towards localisation of energy data in South Africa and Africa. The next 'frontier' will be the disaggregation of city-level energy data. A better understanding of the spatial energy characteristics of the city would enable more targeted, locally appropriate strategies. For example, those responsible for low-carbon city planning in the United Kingdom are looking at creating city divisions along areas of similar energy characteristics, such as city centres, inner-city districts, industrial estates, suburban districts, urban extensions and rural hinterlands.[9] Actions and discussions on similar spatial approaches in Cape Town are under way on a number of fronts:

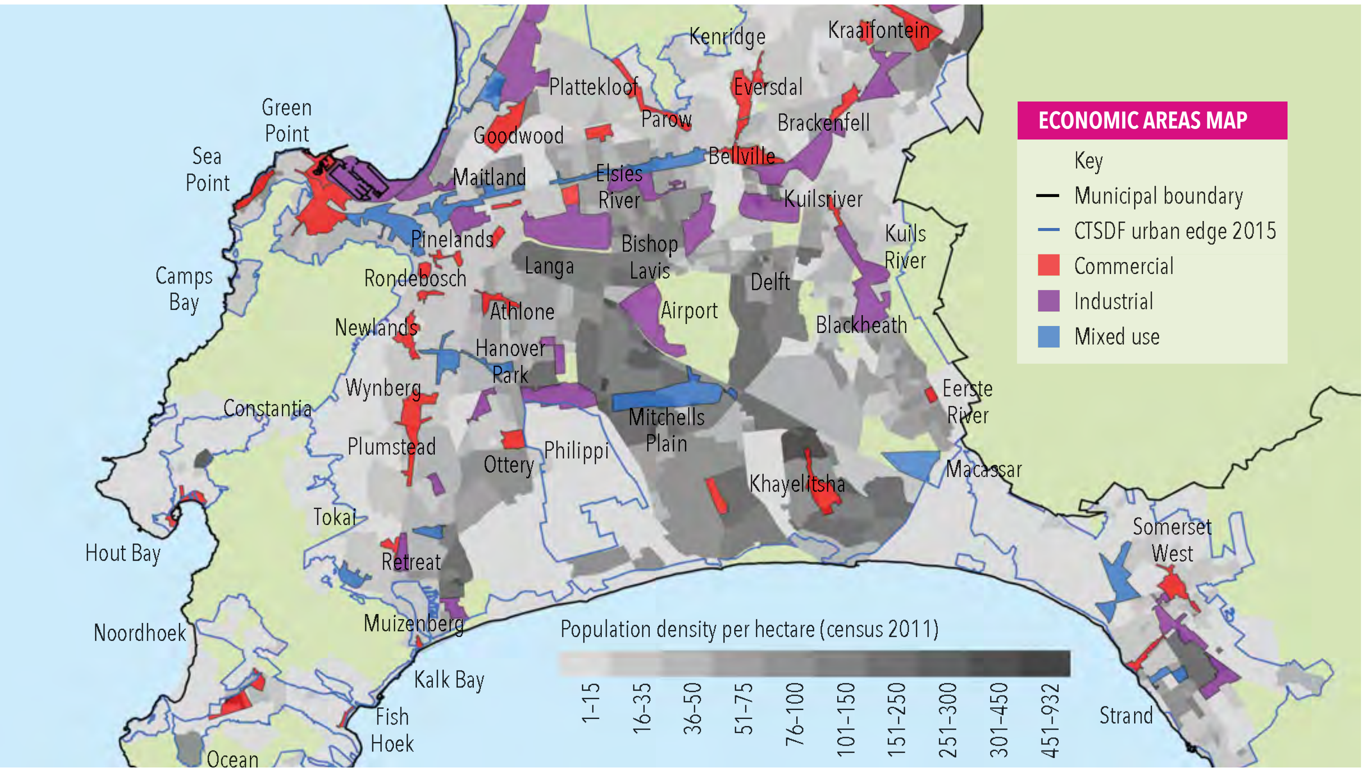
The Low-Carbon Central City Strategy:[10] This initiative, which was funded by the Swedish International Development Cooperation Agency, was led by the Cape Town Partnership and Sustainable Energy Africa in partnership with the City of Cape Town. It involved the first ever disaggregation of city data for the central city. The emerging picture showed that the small central business district (CBD) area accounts for some 4-5% of metro-area energy consumption and emissions. The key strategic areas for energy and emissions management are in transport and commercial buildings. Over 300 000 commuters enter and leave the central city daily using all forms of transport, with private cars dominating (54%), followed by trains (24%), and with buses and minibus taxis comprising 12% and 9% respectively. Currently, only 1% of passenger kilometres into and within the CBD are travelled by means of non-motorised transport.

Assessment of the potential of city rooftop photovoltaic (PV) installations:[11] This study, which was undertaken by Sustainable Energy Africa in partnership with the City of Cape Town and with funding from the British High Commission, explored the rooftop PV potential of the CBD area of Cape Town as well as one industrial zone. The potential impact of rooftop PV generation on central Cape Town is fairly limited due to the type of roof space available. Amongst other factors, the high number of heating, ventilation and air-conditioning (HVAC) systems installed in city buildings means that only 17% of roof space may be used. Given an annual CBD electricity consumption of 1 972 222 MWh and an annual PV generation potential of 101 470 MWh, the potential impact is 5%. The potential within industrial areas is higher, with as much as 90% of roof space being available for use. Epping Industria alone has a capacity for 51 MW of rooftop PV with a potential generation of 303 MWh/day.

Electricity substation load and consumption profiles: The Electricity Services Department will shortly be able to provide electricity consumption data disaggregated to the substation level. This offers enormous potential to model and analyse the impact of interventions on the load, which will enable a far greater refinement of electricity infrastructure system design and understanding of efficiency impacts in terms of costs and benefits.

Disaggregation to economic-zone level: The City's Economic Areas Management Programme (ECAMP) in the Spatial

9. Dodd, Nick, *Community Energy: Urban Planning for a Low Carbon Future,* URBED for TCPA, 2008.
10. Sustainable Energy Africa, Cape Town Partnership, City of Cape Town, *The Low-Carbon Central City Strategy,* 2014, www.cityenergy.org.za.
11. Information on the project as well as the project summary report is available directly from Sustainable Energy Africa.



Planning and Urban Design Department has developed a GIS-based tool that is able to track economic indicators and trajectories at the suburb or area level. This tool identifies areas that are growing or declining as well as the type of businesses in an area, and will enable the City to direct highly targeted interventions to such areas. An energy layer to this initiative would support far more attuned electricity distribution planning, the provision of diverse energy supply options, greater energy efficiency measures, as well as optimal transport infrastructure development.

About ECAMP

The Economic Areas Management Programme (ECAMP) is a ground-breaking research and policy support initiative that tracks and routinely assesses the market performance and long-term growth potential of over 70 business precincts across the metropolitan region. This provides a basis for local interventions to be identified that could help ensure that each business precinct performs optimally given its particular locational assets. For more information, see ctcs.capetown.gov.za/ecamp.

3.4 ENERGY CONVERSION FACTORS

In order to compare energy sources, units have been converted to joules – the standard energy unit. The conversion factors have been drawn from annexure B to the DoE's draft 2012 Integrated Energy Planning Report and are indicated in the table below.

Table 10: Energy conversion factors, South Africa

Energy carrier	Energy	Unit	Energy	Unit	Density (kg/ℓ)	MJ/kg
Aviation gas	33,9	MJ/ℓ	0,0339	GJ/ℓ	0,73	46,4
Coal (general purpose)	24,3	MJ/kg	0,0243	GJ/kg		
Diesel	38,1	MJ/ℓ	0,0381	GJ/ℓ	0,84	45,4
Electricity	3,6	MJ/kWh	0,0036	GJ/kWh		
Heavy fuel oil	41,6	MJ/ℓ	0,0416	GJ/ℓ	0,98	42,3
Jet fuel	34,3	MJ/ℓ	0,0343	GJ/ℓ	0,79	43,3
Liquid petroleum gas	26,7	MJ/ℓ	0,0267	GJ/ℓ	0,54	49,4
Natural gas	41	MJ/m^3	0,0410	GJ/m^3		
Paraffin illuminating, Stats SA data	37	MJ/ℓ	0,0370	GJ/ℓ	0,79	47
Petrol	34,2	MJ/ℓ	0,0342	GJ/ℓ	0,72	47,3

Source: Department of Energy, Draft 2012 Integrated Energy Planning Report, annexure B, "Model Input and Assumptions (Optimisation Model)" (published September 2013).

3.5 EMISSION COEFFICIENTS AND THE GLOBAL PROTOCOL FOR COMMUNITY-SCALE GREENHOUSE GAS EMISSION REPORTING (GPC)

Global air pollution and the GPC

The Global Protocol for Community-Scale Greenhouse Gas Emissions Reporting (GPC) is now the official UNFCCC climate reporting standard for cities. To date, over 100 cities have adopted the GPC to measure their greenhouse gas (GHG) emissions. The World Resources Institute, C40 Cities Climate Leadership Group and ICLEI – Local Governments for Sustainability have partnered to create this standard with due regard to the feedback from the pilot test in 2013 as well as global public comments received in 2012 and 2014, a process in which both Sustainable Energy Africa and the City participated.

Emission factors in this report draw on those of the IPCC for South Africa as well as Eskom data for local electricity emission factors.

The GPC provides a robust framework for accounting and reporting city-wide GHG emissions. It seeks to:

- help cities develop a comprehensive and robust GHG inventory to support planning, target development and performance monitoring;
- ensure consistent and transparent measurement and reporting of GHG emissions between cities, following internationally recognised GHG accounting and reporting principles;
- enable city inventories to be aggregated at subnational and national levels; and
- demonstrate the important role that cities play in tackling climate change, and facilitate insight through benchmarking – and aggregation – of comparable data.

This third Cape Town *State of Energy* report has used the methodology of the GPC for emissions reporting. Emission factors in this report draw on those of the IPCC for South Africa (web-based and regularly updated) as well as Eskom data for local electricity emission factors. Local-level reporting protocols dictate consumption as the basis for emissions accountability. Therefore, even if the emissions take place outside the municipal boundary, if they relate to consumption of energy within this boundary, they are accounted for within the Cape Town's GHG inventory. Local-level inventories, thus, reflect the emission factor relating to the national supply 'mix' for electricity in the country.

Table 11: GHG emission factors for South Africa

South Africa: emission factors						
Energy source	**Unit**	**kg CO_2e per unit**				**Source**
		CO_2	**CH_4**	**N_2O**	**Total**	
Diesel	ℓ	2,6868	0,0091	0,0065	2,7023	www.emissionfactors.com (Intergovernmental Panel on Climate Change (IPCC) 2006, Environmental Protection Agency (EPA) 2015)
Petrol	ℓ	2,2637	0,0082	0,0058	2,2777	
Aviation gasoline	ℓ	2,1915	0,0078	0,0056	2,2049	
Jet kerosene	ℓ	2,5011	0,0087	0,0063	2,5161	
Illuminating paraffin	ℓ	2,5625	0,0089	0,0064	2,5778	
Heavy furnace oil	ℓ	2,9532	0,0095	0,0068	2,9696	
Electricity	kWh	–	–	–	1,0300	Eskom Annual Report, 2011 (incl. transmission and distribution losses)
	kWh	–	–	–	0,9900	Eskom Annual Report, 2011 (excl. transmission and distribution losses)
Natural gas	ℓ	0,0020	0,0000	0,0000	0,0020	www.emissionfactors.com (IPCC 2006, Defra/DECC 2014)
Liquid petroleum gas	ℓ	1,6184	0,0032	0,0008	1,6224	www.emissionfactors.com (IPCC 2006, EPA 2015)
Coal (bituminous)	kg	2,7920	0,0065	0,0115	2,8100	www.emissionfactors.com (IPCC 2006)
Marine fuels	ℓ	2,6868	0,0091	0,0065	2,7023	Set as same for diesel

Source: Compiled by SEA, 2012.

Local air-pollutant emission factors

All fuels burned within Cape Town's boundaries will contribute to local air pollution. The contributions have been developed based on local air-pollutant emission factors supplied by the City of Cape Town Air Quality Department.

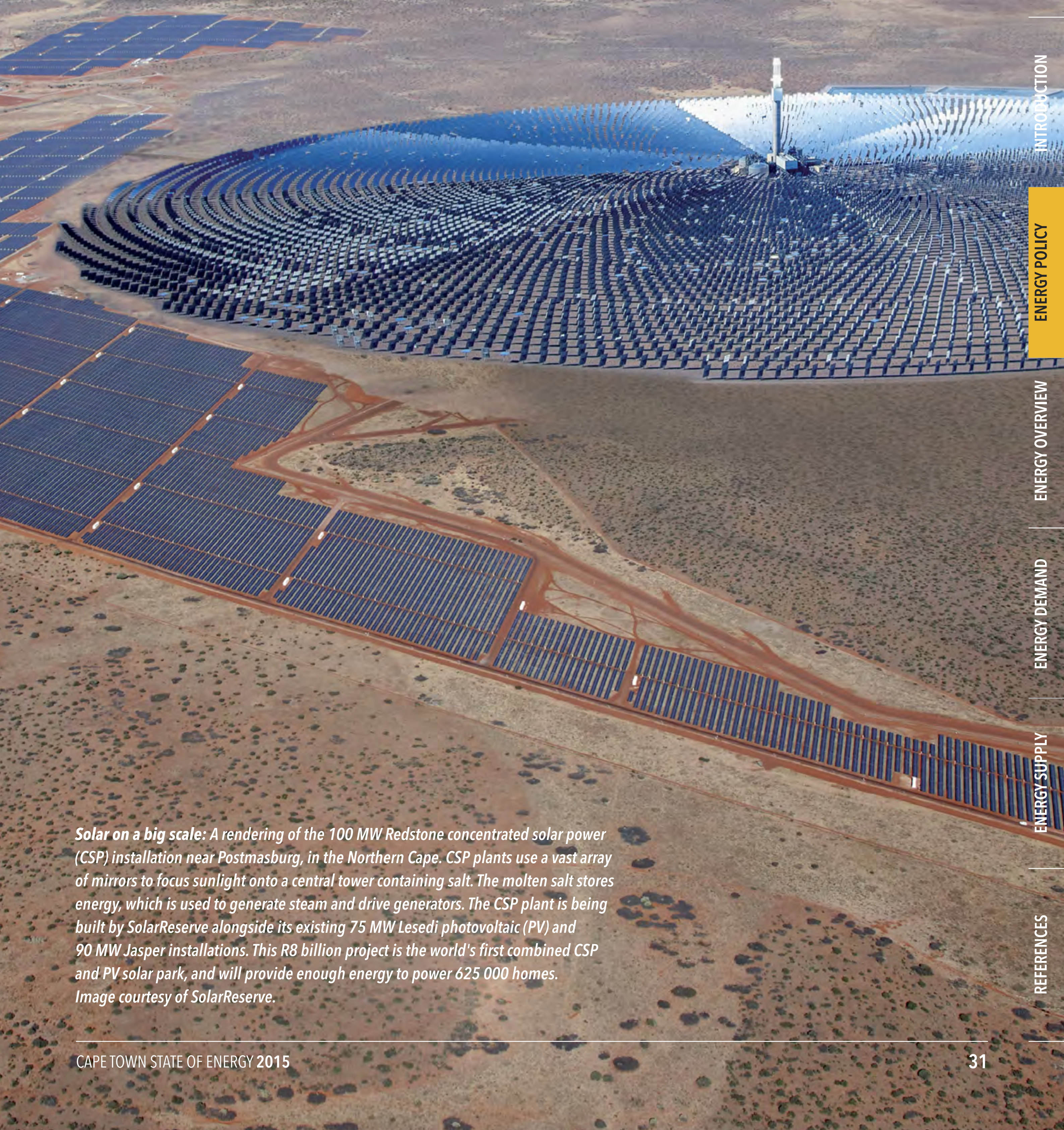
Table 12: Local air-pollutant emission factors

Source	Uncertainty	Units	SO_2	NOx	VOCs	PM^{10}	$PM^{2.5}$
Residential							
Coal	Medium	g/kg	19	1,5	5	4,1	1,64
Paraffin	Low	g/ℓ	8,5	1,5	0,09	0,2	0,2
Liquid petroleum gas	Low	g/kg	0,01	1,4	0,5	0,07	0,07
Wood	Medium	g/kg	0,75	5	22	17,3	12,1
Transport							
Petrol vehicles	Medium	g/ℓ	1,7	18	36	0,6	0,5
Diesel vehicles	Medium	g/ℓ	9,3	6,1	5	6,6	6,1
Brake and tyre wear	Medium	g/km	0	0	0	0,0021	
Paved roads	High	g/km	0	0	0	0,23	
Unpaved roads	High	g/km	0	0	0	75	
Ship diesel	Medium	g/ℓ	9,3	100	4,2	7,1	6,4
Ship bunker oil	Medium	g/ℓ	63	32	6	3,7	3,3

Source: City of Cape Town, Air Quality Department, 2014.

4 THE **ENERGY POLICY** ENVIRONMENT

South Africa is developing an energy regime that is moving towards a more diverse, secure, needs-oriented and environmentally sustainable system. Growing awareness of the impact of fossil fuel consumption and the role of energy demand management is articulated in numerous national policies and regulations.



Solar on a big scale: *A rendering of the 100 MW Redstone concentrated solar power (CSP) installation near Postmasburg, in the Northern Cape. CSP plants use a vast array of mirrors to focus sunlight onto a central tower containing salt. The molten salt stores energy, which is used to generate steam and drive generators. The CSP plant is being built by SolarReserve alongside its existing 75 MW Lesedi photovoltaic (PV) and 90 MW Jasper installations. This R8 billion project is the world's first combined CSP and PV solar park, and will provide enough energy to power 625 000 homes. Image courtesy of SolarReserve.*

4.1 NATIONAL POLICY AND LEGISLATIVE CONTEXT

South Africa's policy and regulatory environment post-1994 is transitioning to an energy regime that is moving away from an over-reliance on supply-driven planning and carbon-intensive fuels towards a more diverse, secure, needs-oriented and environmentally sustainable system. Surely, the most impressive outcome of this is the Renewable-Energy Independent Power Producers Programme (REIPPP). Led by the Department of Energy and the Public Private Partnerships (PPP) Unit of National Treasury, this programme has seen the development of 47 new solar and wind projects in the first two bidding rounds. After the third bidding round, 3,5 GW of renewable energy will have been committed and another 3,2 GW will have been tendered.[12]

Inevitably, there have been great strides as well as significant setbacks along the way: Due to electricity supply constraints, government's 2010 Integrated Resources Plan (IRP) was developed prior to the development of the country's Integrated Energy Plan. Public participation in the development of these plans saw some improvement to the IRP. However, the country's plans for nuclear energy development seem to be taking place independent of this national planning process. Tension remains between the call for more flexible, demand-responsive power supply options articulated in the 2013 National Development Plan (NDP) and the 'old school' of large, centralised coal and nuclear plants.

Growing awareness of the global impact of fossil fuel consumption and the increasingly important role of energy demand management, articulated in numerous national policies and regulations, has brought urban energy management to the fore.

Growing awareness of the global impact of fossil fuel consumption and the increasingly important role of energy demand management, articulated in numerous national policies and regulations, has brought urban energy management to the fore. However, roles and mandates relating to this are often indirect and indistinct, and the current regulatory environment and management system include contradictions that have to be addressed. An illustration of how this plays out at the local government level is the obligation imposed on local governments to supply services in a sustainable manner, which entails both cost recovery/revenue-raising through the sale of water and electricity, and renewable energy development and energy efficiency. However, under the current system, energy efficiency and loss of sales through embedded renewable energy development mean that the one priority is pitted against the other.

12. Eberhard, A, *The folly of big coal, big nuclear and big networks*, seminar presentation, Energy Research Centre, Graduate School of Business, University of Cape Town, 4 September 2013.

Table 13: Key national legislation and policies relating to city energy development

Legislation/policy	Objectives	Key points
White Paper on Energy Policy, 1998	• Increasing access to affordable energy services • Improving energy governance • Stimulating economic development • Managing energy-related environmental and health effects • Securing supply through diversity.	• Foundation of national energy policy • Focus on energy poverty alleviation, which has resulted in widespread electrification and subsidised electricity for the poor • Diversification of supply to ensure energy security, which lays the foundation for alternative generation technologies, including renewable energy.
White Paper on Renewable Energy, 2004	• Promoting and implementing renewable energy in South Africa • Setting a target of 10 000 GWh of renewable energy by 2013.	• Focus on government support to achieve renewable-energy targets • Does not specifically look to support embedded generation, which remains somewhat of a policy vacuum.
National Energy Efficiency Strategy, 2005	Vision to ensure affordable energy for all and minimise the negative effects of energy usage on human health and environment through sustainable energy development and efficient practices. Overall target of 12% energy efficiency for the country by 2015.	• Strong call for energy efficiency in all economic sectors, with reasonably ambitious targets • The National Energy Efficiency Action Plan, developed to better implement the strategy, makes mention of the role of local government in implementation.
Energy Act (Act 34 of 2008)	Mandates the DoE to ensure that diverse energy resources are available in sustainable quantities and at affordable prices to support economic growth and poverty alleviation, while also taking into account environmental considerations.	• Strong focus on diversifying supply • Strong focus on increasing renewable energy generation.
Draft Integrated Energy Plan, 2012	Identifies eight policy objectives derived from the White Paper/Energy Act, looking to meeting these under various scenarios.	• The eight policy objectives of the Draft Integrated Energy Plan, 2012, strongly mirror local government roles and mandates.
Integrated Resource Plan, 2010	The IRP 2010 determines the demand profile for electricity over the next 20 years and details how this demand can be most effectively met from different sources. Its objectives are to: • provide a framework to ensure electricity supply • ascertain capacity investment needs and consider externalities • address the current demand and the supply costs.	• Electricity demand has been significantly reduced from what was contained in earlier plans. • An IRP 2010 update report published in 2013 presented a 'decision-tree' approach for more flexible, dynamic planning in a time of uncertainty. It also introduced the possibility of embedded generation as part of the national supply mix. However, this report was not accepted by Cabinet due to conflict with the nuclear programme.
National Nuclear Regulator Act, 1999 Nuclear Energy Act, 1999 Nuclear Energy Policy and Strategy, 2008	Provide a governance framework for the industry. Aim to increase the role of nuclear energy as part of the process of diversifying South Africa's primary energy sources to ensure energy security.	• The policy enables nuclear energy to be treated outside the usual policy prescriptions and processes • Nuclear energy is promoted as an important part of a diversified energy mix.
Electricity Regulation Act (2006, amended 2008)	The act establishes a national framework for the electricity supply industry, from generation to distribution. It makes provision for energy efficiency measures to be promulgated and ensures that incentives and penalties are legislated.	• Allows for budget to be allocated for energy efficiency specifically • Strong focus on municipalities for implementation.
NERSA Standard Conditions for Small-Scale Embedded Generation, 2011	This policy document makes provision for small-scale embedded energy generation.	• Small-scale embedded generation may take place and will largely be the responsibility of local distributors to approve, monitor and regulate • Related standards to guide this are being developed.
SANS 204 and the National Building Regulations Part XA, "Energy Efficiency", 2011	This document provides for the amendment of the National Building Regulations to include energy efficiency standards in all residential and commercial buildings. Importantly, it includes water heating, where at least 50% of heating needs must be met by non-electrical resistance means. The amendment has made provision for a building envelope, fenestration, passive solar heating and insulation.	• Except under exceptional circumstances, solar water heating is now a requirement for all new buildings. • A government circular of December 2013 has extended the amended regulations to apply to all government-delivered, low-income housing.
Petroleum Products Act, 1977	This act provides measures for the efficient and effective distribution of petroleum products and price control.	
White Paper on National Climate Change Response, 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 generation mix as the main interventions/opportunities for mitigation.	• The policy specifically identifies a role for local government in implementation and identifies the South African Local Government Association (SALGA) as a key support institution.

***Power project:** Darling Wind Farm was the first in the country to supply local government with wind-generated electricity, and was an important pilot site for the national Renewable-Energy Independent Power Producers Programme (REIPPP).*

4.2 ENERGY-RELATED LOCAL GOVERNMENT MANDATES AND FUNCTIONS EMANATING FROM NATIONAL POLICY

The constitutional objectives accorded to local government in the **Constitution of the Republic of South Africa** (1996) include the provision of services to communities in a sustainable manner, the promotion of social and economic development, and a safe and healthy environment (section 152(1)). The Constitution also sets out the powers and functions of municipalities (section 56(1) and schedules 4B and 5B), which include some aspects relating to air pollution, building regulation, electricity and gas reticulation, municipal planning and street lighting. These functions 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.[13]

Municipalities are also identified as key partners, with SALGA as a key support, in the implementation of lower-carbon pathways in line with the **National Climate Change Response Strategy** (section 10.2.6).

Section 23 of the **Municipal Systems Act** (No 32 of 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. This underpins the development of a detailed energy and climate change strategy and energy and climate action plan for Cape Town (as a component of the legislated Integrated Metropolitan Environmental Policy).

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 Financial 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.

Amongst South African cities, the City of Cape Town has been a pioneer in local government taking an active role in developing and managing sustainable energy strategies. The **2006 City of Cape Town Energy and Climate Change Strategy** was the first of its kind in the country and, indeed, in Africa. This strategy has set a target of 10% renewable energy and cleaner energy supply by 2020. The City has developed a sizeable **Energy and Climate Change Unit**, the activities of which are guided by the **2010 Energy and Climate Action Plan (ECAP)**. These policies and plans have been institutionalised within the City's **Integrated Development Plan** since 2010.

The 2006 City of Cape Town Energy and Climate Change Strategy – the first of its kind in the country and, indeed, in Africa – has set a target of 10% renewable energy and cleaner energy supply by 2020.

Achievements in energy efficiency and renewable energy development are significant (see table 42: Summary overview of efficiency projects in City operations, 2009–2014) and include efficient retrofits of traffic and street lighting, retrofits of municipal buildings, an energy-efficient behaviour campaign across the city, the establishment of the Commercial Energy-Efficiency Forum, a solar water heater marketing campaign and accreditation programme, and ceiling retrofits in government-delivered housing.

Diversification of the energy mix includes purchase of wind-generated power from Darling Wind Farm, hydro power in potable water systems, energy from wastewater and small-scale rooftop PV generation (municipal and private rooftops as of late 2014).

Table 14: Local government powers and functions relevant to achieving national energy objectives

Eight key national integrated energy objectives (Draft National Integrated Energy Plan, 2012)	Associated municipal mandates or functions (schedules 4 and 5, RSA Constitution, 1996 Municipal Systems Act Municipal Services Act)
1. Ensure the security of supply	Electricity reticulation; free basic energy
2. Minimise the cost of energy	Electricity reticulation (tariff-setting, cross-subsidisation); human settlements (housing delivery); public transport (limited); non-motorised transport
3. Increase access to energy	Electrification; free basic alternative energy; human settlements (thermal efficiency); public transport; spatial planning
4. Diversify supply sources and primary sources of energy	Electricity reticulation; waste management
5. Minimise emissions from the energy sector	Electricity reticulation; building codes and planning approval
6. Promote energy efficiency in the economy	Manage public facilities; building codes and development approval; air quality management; electricity distribution
7. Promote localisation and technology transfer and the creation of jobs	Local economic development
8. Promote the conservation of water	Water service delivery

Source: SALGA-led Local Government Energy Efficiency and Renewable Energy Strategy status quo report, 2014.

13. Cliffe, Dekker & Hofmeyr legal opinion, as contained, in SACN/Aurecon report, 2013.

5 CAPE TOWN **ENERGY SUPPLY AND DEMAND** OVERVIEW

Electricity, petrol and diesel are the major fuels supplying Cape Town, with transport being the dominant energy consumer in the city. Its large harbour and airport alone accounted for approximately 11% of total energy and 17% of transport energy in 2012.

5.1 THE CURRENT PICTURE

The major fuels supplying the Cape Town energy market are electricity and fossil-based liquid fuels, predominantly petrol and diesel. Electricity is almost entirely supplied by state-owned enterprise Eskom, whose fuel supply is predominantly (approximately 95%) coal-derived, with the nuclear power station at Koeberg comprising the remaining 5%. To date, renewable energy capacity to the tune of 3 900 MW has been built and in early 2014, some of the first renewable energy sourced through the REIPPP came on line. Although the actual contribution of renewable energy to the national mix has still not been quantified, the Cabinet-approved IRP 2010 (policy-adjusted scenario) indicates targets of 5% renewable-source electricity by 2020 and 9% by 2030.

The City purchases a small amount of wind-generated energy from Darling Wind Farm through a 20-year power purchase agreement (PPA). Initially, the power was bought at a premium. Some was sold on to willing buyers and the difference underwritten by the Global Environmental Fund. Currently, the Darling power costs the City slightly less per unit than Eskom power. Although a miniscule amount of PV small-scale embedded generation (SSEG) was in place in 2012, any power generated in this sector would have been recorded as 'efficiency' demand reduction (i.e. consumed on-site rather than fed into the grid).

The City has limited generation capacity and its three power stations (Steenbras pumped storage facility and the Athlone and Roggebaai gas turbines) are used for load management rather than being base-load generators. Steenbras shifts 'peak' demand in the city by some 6,5%, saving the City financially, but is a net consumer of power. Athlone and Roggebaai (diesel-fired) both contribute extremely small amounts to demand management during winter months.

Liquid fuels are imported and refined at local refineries along the coast. Most liquid fuels supplied to the Cape Town market come directly from the local Caltex refinery. SAPIA reports liquid-fuel sales data to the Department of Energy on a monthly basis. Coal is deregulated, however, and distribution data must be obtained directly from suppliers or consumers. Coal comes into Cape Town through private distributors from mines upcountry and constitutes a relatively small component of the energy market (approximately 3%).

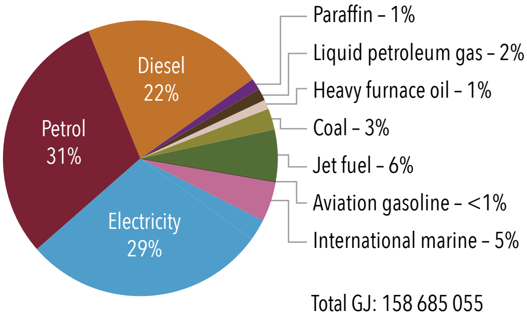
The major fuels supplying the Cape Town energy market are electricity and fossil-based liquid fuels, predominantly petrol and diesel. Electricity is almost entirely supplied by state-owned enterprise Eskom.

Table 15: Energy demand (GJ) by energy type and sector, Cape Town, 2012

Energy source	Residential	Commercial	Industrial	Transport	Government	Agriculture	Electricity losses	Total	% total
Electricity	16 073 504	18 964 488	5 584 009	–	1 618 120	760 570	3 792 024	46 792 716	29%
Petrol	–	–	–	48 827 797	205 090	–	–	49 032 887	31%
Diesel	–	–	–	34 570 951	380 981	–	–	34 951 932	22%
Paraffin	1 665 383	339 714	160 790	–	–	325		2 166 212	1%
Liquid petroleum gas	608 771	608 771	1 217 542	–	–	–	–	2 435 083	2%
Heavy furnace oil	–	130 186	1 503 735	–	–	–	–	1 633 921	1%
Coal	6 124	317	4 075 959	–	–	–	–	4 082 400	3%
Natural gas	–	–	–	–	–	–	–	–	0%
Jet fuel	–	–	–	10 062 689	–	–	–	10 062 689	6%
Aviation gasoline	–	–	–	30 371	–	–	–	30 371	0%
International marine	–	–	–	7 496 844	–	–	–	7 496 844	5%
Total	**18 353 781**	**20 043 476**	**12 542 036**	**100 988 653**	**2 204 190**	**760 895**	–	**158 685 055**	–
% total	**12%**	**13%**	**8%**	**64%**	**1%**	**0%**	**2%**	–	–

Figure 1: E nyergc osymup t bisy , c eyergc msuroeC aTt e ws2 yC0: 10*

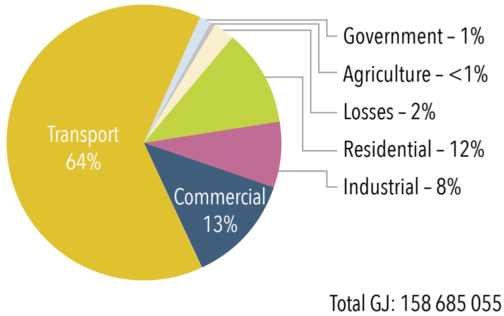
* Including aviation, international marine and electricity losses (electricity losses included in the electricity value)



Source: City of Cape Town, Eskom, Province, SAPIA.

Figure 11: Energy consumption by sector, Cape Town, 2012*

* Including aviation, international marine, electricity losses



Source: City of Cape Town, Eskom, Province, SAPIA.

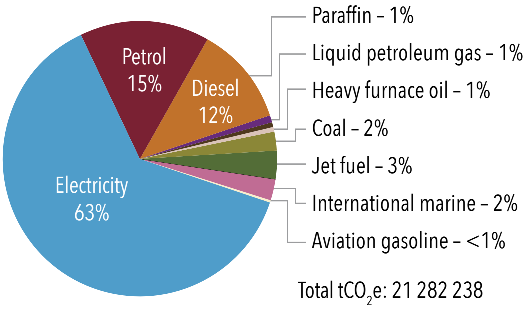
Transport continues to dominate energy consumption in Cape Town. This is made up of passenger, commercial, industrial (petrol and diesel) and aviation and marine transport. Cape Town has a large harbour and international airport accounting for approximately 11% of total energy and 17% of total transport energy in 2012.[14]

When examining the energy profile from a climate change-related emissions perspective, the picture is somewhat different: Here, electricity consumption by the residential, commercial and industrial sectors dominates the picture. This is due to the very high carbon component within the current South African electricity generation mix.

Energy data for Cape Town have now been collated in three intensive exercises since 2001. This provides a basis from which to analyse trends, but also highlights the constraints that are still encountered when assembling data.

Figure 12: Carbon emissions by energy source, Cape Town, 2012*

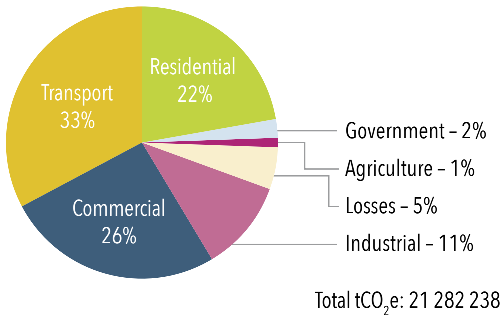
* Including aviation, international marine and electricity losses (electricity losses included in the electricity value)



Source: City of Cape Town, Eskom, Province, SAPIA.

Figure 13: Carbon emissions by sector, Cape Town, 2012*

* Including aviation, international marine, electricity losses



Source: City of Cape Town, Eskom, Province, SAPIA.

In the context of rising supply prices, electricity supply constraints and global emissions-related environmental threats, energy management in Cape Town needs to focus on all sectors. Climate change presents not only an environmental threat, but also a threat to the economy and the reputation of cities unable to reduce emissions levels. Municipal powers and functions relating to energy use are extensive (see table 14: Local government powers and functions relevant to achieving national energy objectives) and aspects of energy management will need to be implemented and maintained across almost all municipal departments.

5.2 TRENDS AND DEVELOPMENTS: DEMAND AND SUPPLY OVERVIEW

Energy data for Cape Town have now been collated in three intensive exercises since 2001. This provides a basis from which to analyse trends, but also highlights the constraints that are still encountered when assembling data. For example, high year-to-year variability in SAPIA's liquid fuel data (notably for international marine and aviation), as well as the publication in different years of different datasets with varying data figures for past years, obfuscates trends.

Population and economic growth in Cape Town has largely matched that of the Western Cape province and has been higher than that of the country overall, which points to relative growth in the region. In the period 2007–2012, growth was slower compared to 2001–2007, with growth rates halving at city, province and national level.

The city's population represents two-thirds (64%) of the provincial population and nearly three-quarters (73%) of economic value; yet, energy consumption in Cape Town is only half of that for the province. Similarly, at a national level, energy con-

14. In 2010, the data for aviation and international marine fuels were extremely high, and no international marine or aviation data were collected in the 2003 Cape Town *State of Energy* report, making it difficult to establish a benchmark proportion for these fuels at this stage.

Table 16: Cape Town, Western Cape and South African population and GVA growth over time

	Value			Average growth per annum	
	2001	2007	2011	2001-2007	2007-2011
Population					
Cape Town	2 892 243	3 374 572	3 740 026	2,60%	2,60%
Western Cape	4 524 335	5 263 784	5 971 510	2,56%	3,20%
South Africa	44 819 777	48 869 467	52 522 355	1,45%	1,82%
GVA (constant 2005 ZAR)					
Cape Town	124 928	169 998	185 682	5,27%	2,23%
Western Cape	169 645	230 569	253 619	5,25%	2,41%
South Africa	1 192 559	1 561 077	1 692 725	4,59%	2,04%

Source: Quantec, Stats SA Census 2001, 2007, 2011 mid-year estimate.

sumption is proportionally lower than economic value contribution and population. This is due to the composition of Cape Town's economy, which is dominated by tertiary-sector activities (low energy intensities) and limited heavy industry.

Table 17: Cape Town energy consumption, population and economy as a proportion of Western Cape (province) and South Africa (national)

	% province	% national
General		
Population	64%	7%
Economy	73%	11%
Energy source		
Electricity	57%	6%
Coal	7%	1%
Petrol	83%	12%
Diesel	69%	8%
Paraffin	80%	11%
Liquid petroleum gas	50%	14%
Heavy furnace oil	34%	8%
Jet fuel	67%	12%
Aviation gas	42%	3%
Total	**54%**	**7%**

Source: SEA 2015.

Total energy consumption in Cape Town has continued to grow in absolute terms. However, although growth in Cape Town's energy consumption between 2001 and 2012 was 29,1% (excluding international marine and aviation fuel), it was slightly less than the population and economic growth rates. As the economy has continued to grow at a slightly faster rate than energy consumption, and in particular *electricity* consumption, this indicates a trend towards the decoupling of economy and energy, i.e. growing economic value produced off lower levels of energy input into the system.

Table 18: Average annual growth rate: population, economy and energy consumption for Cape Town, 2001–2007 and 2007–2012

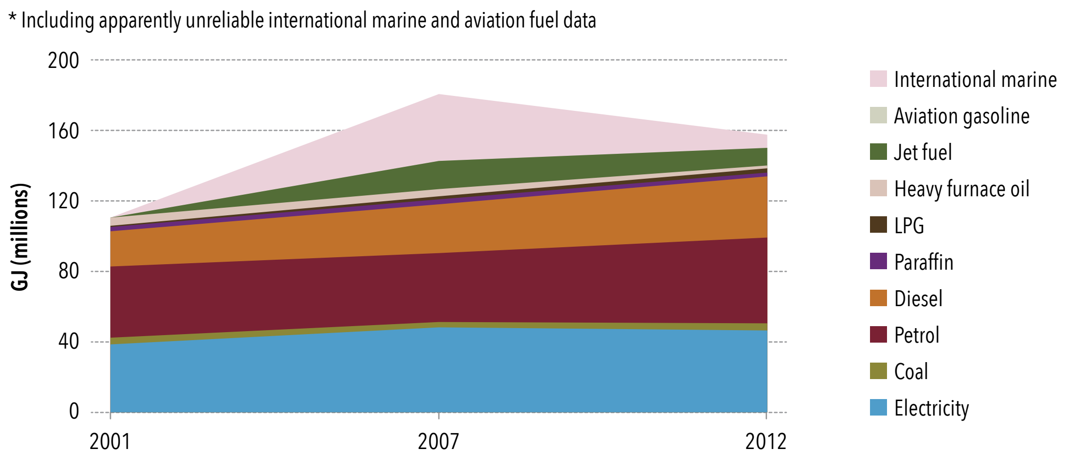
	2001-2007	2007-2012
Population	2,60%	2,60%
Economic growth (GVA)	5,27%	2,52%
Energy consumption (GJ)	2,61%	2,03%

Note: Energy figures exclude international marine and aviation in order to facilitate comparison.
Source: SEA, Stats SA, Quantec.

As the economy has continued to grow at a slightly faster rate than energy consumption, and in particular electricity consumption, this indicates a trend towards the decoupling of economy and energy.

Fuel figures for international marine across the periods 2007-2009-2012 vary significantly, making them unreliable. Given the questionable data from SAPIA relating to international marine prior to 2010 and the absence of aviation fuel in the 2001 data, both of these sectors have been left out of the time series analysis going forward.

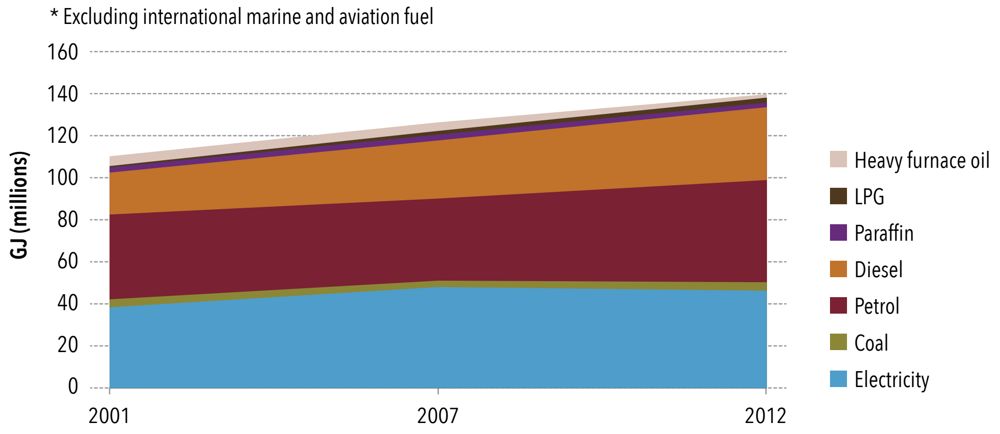
Figure 14: Energy consumption by energy source, Cape Town, 2001–2012*



Source: City of Cape Town, DoE, Eskom, SAPIA, SEA.

The decline in electricity consumption in Cape Town from 2007 is led by decreasing demand in the residential sector. During this period, there were steep price increases, an economic downturn, active electricity-saving campaigning, and a roll-out of prepaid meters.

Figure 15: Energy consumption by energy source, Cape Town, 2001–2012*



Source: City of Cape Town, DoE, Eskom, SAPIA, SEA.

Changing energy consumption patterns are detailed in table 19 below. However, all energy-related discussions must bear in mind the data challenges outlined in this table, i.e. any apparent consumption change must be examined to ensure that the change does not simply reflect data changes or inaccuracies over time.

Table 18 (on previous page) shows that the period between 2001 and 2007 saw faster growth, with a slight slowing from 2007 to 2012. The flattening of the electricity demand curve from 2007 onwards is notable. Demand for petrol and diesel continued to grow over the ten-year period.

Table 19: Energy consumption and carbon emissions changes according to data collated in 2001, 2007 and 2012

Energy source		2007-2012			Data comment
	GJ	tCO_2e	GJ	tCO_2e	
Note: *Changes in tCO_2e relative to GJ relate in part to changing emission factors.*					
Electricity	-4%	-10%	25%	32%	Data very reliable.
Coal	34%	64%	-20%	-20%	Coal data for 2007 not reliable, hence fairly large increase recorded. Large emission increase due to changing carbon content of coal over time.
Petrol	24%	20%	-3%	-3%	More recently published national dataset contains higher 2007 figures, which makes this growth seem a bit high.
Diesel	25%	20%	38%	38%	More recent national dataset contains higher 2007 figures, which makes this growth seem a bit high.
Paraffin	-23%	-26%	16%	16%	Decline reflects household consumption changes, with electricity replacing paraffin.
Liquid petroleum gas	39%	34%	156%	156%	Large increase.
Heavy furnace oil	-60%	-63%	-12%	-12%	This reflects a trend across national data. No understanding of whether this is a data issue or relates to actual consumption changes.
Jet fuel	-37%	-36%			Data concerns noted.
Aviation gasoline					
International marine	-80%	-82%			Data concerns noted.
Total	-13%	-14%	63%	50%	
Total excluding aviation and marine	11%	-3%	15%	25%	Substantial differences in GJ to tCO_2e relate to changing emission factors, particularly for coal.

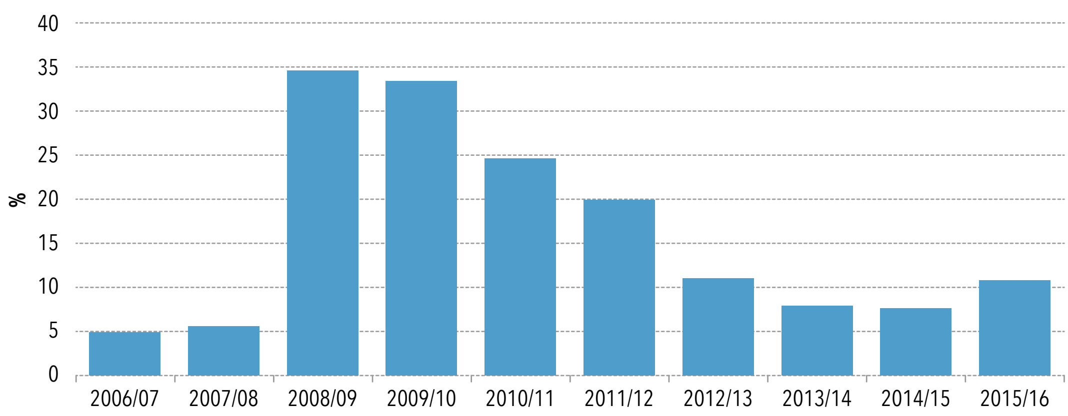
Source: Cape Town State of Energy 2003 and 2011.

The initial energy growth for the period 2001–2007 (2,6%) tracks a strong GVA growth over this period (5,2%), though is not commensurate to this growth, probably because economic growth is led by the financial sector, which is a relatively low-energy intensive sector. The decline in electricity consumption in Cape Town from 2007 is led by decreasing demand in the residential sector in particular. During this period, there were steep price increases, an economic downturn, active electricity-saving campaigning by both the City and Eskom, and a roll-out of prepaid electricity meters across the city. Electricity demand from commerce and industry, although not showing absolute decline, does also flatten out during this period. The growth in Cape Town's financial and service sectors may also be a contributing factor. These sectors are not only less energy-intensive, but may well have a more elastic demand in relation to price changes.

Growth in total energy demand between 2007 and 2012 was just above the business-as-usual (BAU) scenario modelled in the Long-Range Energy Alternatives Planning (LEAP) programme in 2011, and substantially above an 'optimum energy future' scenario, which would have had Cape Town moving in the direction required for sustainable development and climate mitigation.

Growth would in fact have been above BAU if it weren't for the decrease in electricity consumption experienced in the city

Figure 16: Average electricity price increases, Cape Town, 2006–2015



Source: City of Cape Town Electricity Services Department.

Table 20: Actual vs projected (LEAP model) energy consumption in Cape Town, 2007–2012

Actual vs. projected energy consumption in Cape Town	Total increase	Average annual increase
Projected: business-as-usual (2007-2012)	10%	1,9%
Projected: optimum energy future (2007-2012)	4%	0,7%
Actual (2007-2012)	10,58%	2,03%

Source: SEA, 2015, LEAP model and related projections from the Optimum Energy Futures report, 2011 (2007 baseline year).

from around 2008. This trend is apparent nationally and in other metros in the country. The continued growth in total energy demand is led by growth in transport-related fuels. Petrol and diesel consumption increased at a rate above the projected BAU growth.

The table below shows energy consumption and growth across sectors in Cape Town between 2001 and 2012.

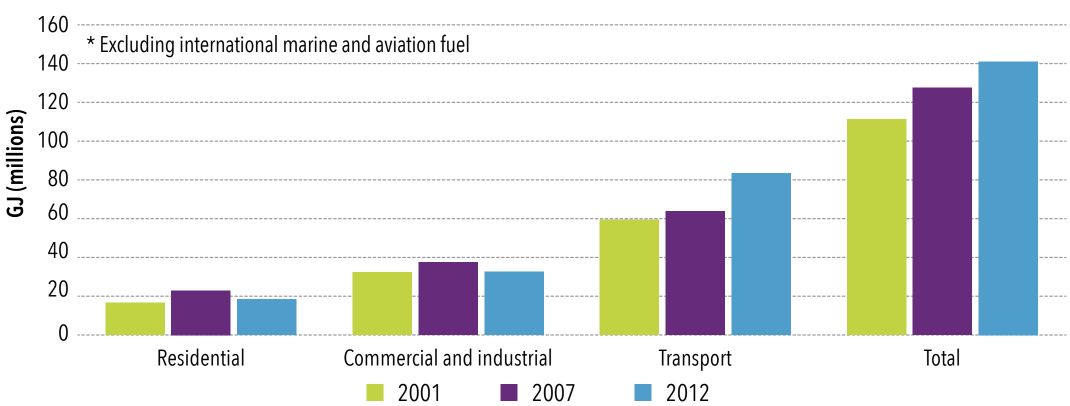
The decrease in residential-sector energy demand between 2007 and 2012, which rendered demand close to 2001 levels, is notable. Transport is the strong driver of increasing energy consumption over this period.

Table 21: Energy consumption by sector, Cape Town, 2001–2012 (excluding international marine and aviation fuels)

	Residential	Commercial and industrial	Transport	Local government	Agricultural	Total
2001	16 562 333	32 346 563	59 538 212	1 784 679		**109 311 370**
2007	22 976 123	38 293 538	65 099 015	1 276 451		**127 645 128**
% change 2001-2007	5,6%	2,9%	1,5%	-5.40%		**2,6%**
2012	18 353 781	32 585 512	83 398 749	2 204 190	760 895	**141 095 151**
% change 2007-2012	-4,4%	-3,2%	5,5%	11,5%		**2,0%**
% change 2001-2012	10,8%	0,7%	29,1%	23,5%		**26,8%**

The decrease in residential-sector energy demand between 2007 and 2012, which rendered demand close to 2001 levels, is notable. This was driven by decreases in electricity and paraffin use. Transport is the strong driver of increasing energy consumption, particularly in the 2007–2012 period. For commerce and industry (combined to improve comparability over years), the most reliable figure, given changes in coal consumption data for 2007, is the 2001–2012 annual average, which is fairly flat. Increases recorded in local government consumption were due to the inclusion in 2012 of vehicle fuel and the improved monitoring of electricity consumption.

Figure 17: Energy by sector, Cape Town, 2001–2012*



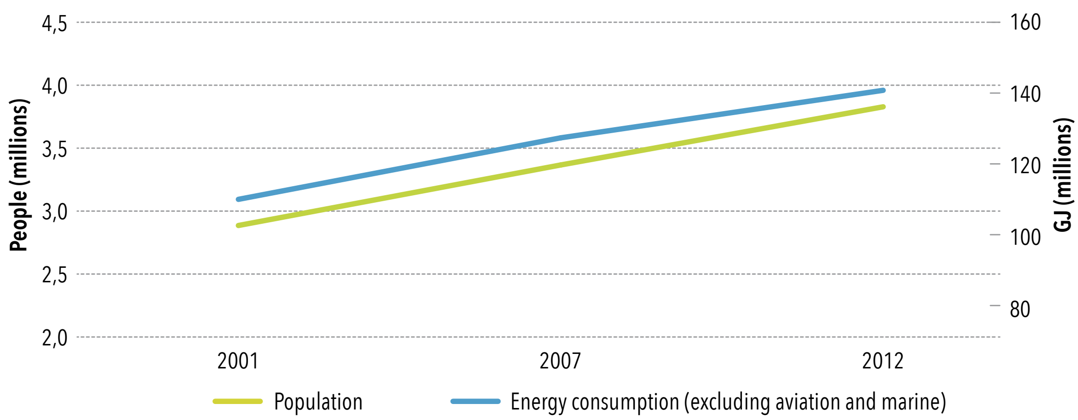
Source: City of Cape Town, DoE, Eskom, SAPIA, SEA.

The city's absolute growth in energy consumption is driven by population and economic growth. However, per-capita energy consumption decreased slightly, from 37 GJ/capita in 2001 to 36 GJ/capita in 2012, i.e. the population grew at a more rapid pace than energy consumption. This could be attributed to population growth amongst lower-energy consumers (thereby expanding the group of lower-income consumers) and efficient electricity use, particularly in middle-income households.

Economic growth and energy show similar overall growth trends, but changes in the economic growth rate do not appear to have an immediate or absolute/direct impact on energy demand. The economic impact of changes in the energy sector, notably price changes, and the consequent change in energy demand is a new area of analysis. The Cape Town data indicate that the residential sector has responded quickly to changing electricity prices, although other sectors have not shown a dramatic drop in demand. Coal suppliers do indicate that they have been witnessing a fuel switch, with industrial customers replacing electricity with coal, where feasible.[15]

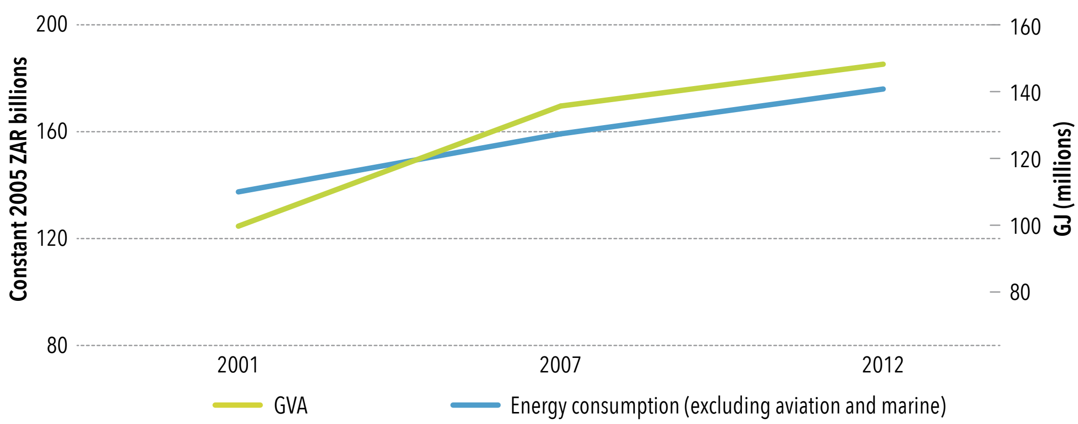
The Cape Town data indicate that the residential sector has responded quickly to changing electricity prices; other sectors have not shown a dramatic drop in demand.

Figure 18: Energy and population growth, Cape Town, 2001–2012



Source: City of Cape Town, DoE, Eskom, SAPIA, SEA, Stats SA.

Figure 19: Energy and economic growth, Cape Town, 2001–2012



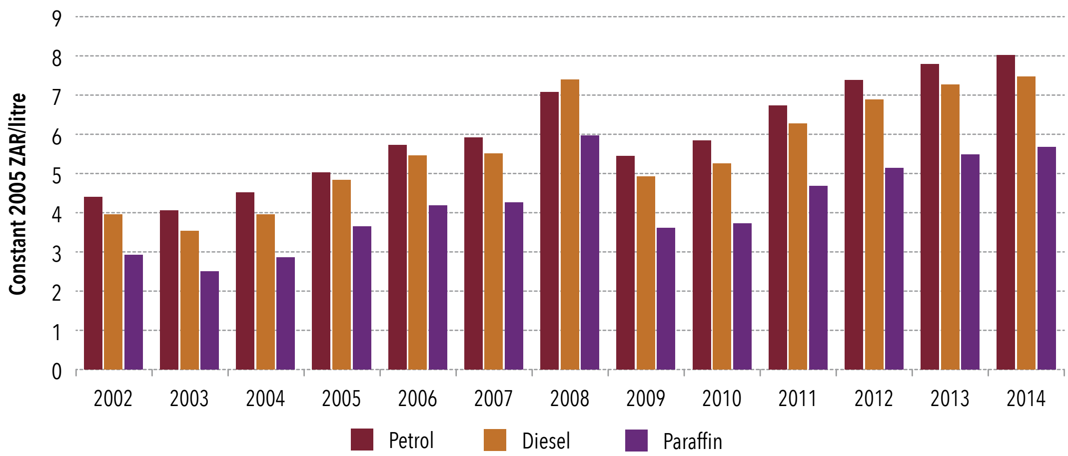
Source: City of Cape Town, DoE, Eskom, SAPIA, SEA, Stats SA.

Price increases within the transport sector have been less dramatic than within electricity, but still sizeable. Petrol almost doubled in cost in real terms between 2002 and 2014. While the response to price increases within the electricity sector indicates some degree of elasticity of demand (i.e. customers reducing their energy consumption and/or meeting their energy needs through alternative services as price increases), particularly within the residential sector, the same has not been visible in the transport sector.

Car ownership and, therefore, passenger fuel consumption have grown during this period, despite real price increases. Likely factors contributing to this transport-sector growth (and relative inelasticity of demand) include growth of household income, increasing sprawl of the city, lack of adequate and safe public transport options and a degree of inelasticity through 'lock-in', i.e. it not being a quick decision to move house or change children's schools in order to reduce trip distance. Although there was a price increase over the entire period, indications are that the decrease in the petrol price in 2009 sent people back to their cars.

15. Personal communication with coal supplier, Cape Town, February 2015.

Figure 20: South Africa liquid fuel prices (ZAR constant 2005/ℓ), 2002–2014



Source: DoE, Stats SA.

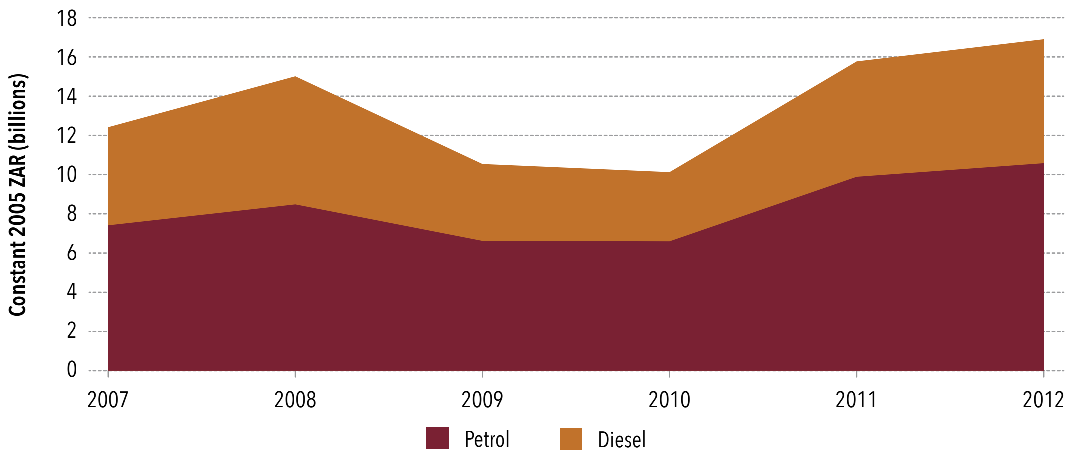
Car ownership and, therefore, passenger fuel consumption have grown. Likely factors contributing to this include growth of household income, increasing sprawl of the city, lack of adequate and safe public transport options and a degree of inelasticity through 'lock-in', i.e. it not being a quick decision to move house or change children's schools in order to reduce trip distance.

Liquid fuels comprise over half of the energy consumed in Cape Town. This renders the Cape Town economy vulnerable to fuel price fluctuations.

Table 22: Total cost of petrol and diesel consumption, Cape Town, 2007–2012

Cost (constant 2005 ZAR)	2007	2008	2009	2010	2011	2012
Petrol	7 414 146 856	8 481 721 180	6 619 135 133	6 597 939 512	9 888 109 467	10 582 731 477
Diesel	5 004 797 745	6 533 983 766	3 922 651 138	3 529 190 518	5 885 482 715	6 322 826 077

Figure 21: Total cost of petrol and diesel consumption, Cape Town, 2007–2012



Source: DoE, SAPIA, Stats SA.

5.3 ENERGY AND GREENHOUSE GAS EMISSIONS

Table 23: Energy-related GHG emissions by energy source and sector (tCO_2e), Cape Town, 2012

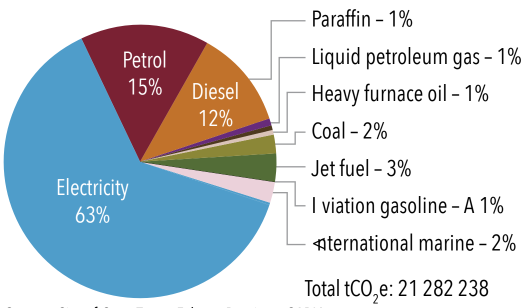
Fuel	Residential	Commercial	Industrial	Transport	Government	Agriculture	Electricity losses	Total	% Total
Electricity	4 598 808	5 417 747	1 597 647	–	462 962	217 608	1 084 940	13 379 712	63%
Petrol	–	–	–	3 250 903	13 655	–		3 264 558	15%
Diesel	–	–	–	2 451 725	27 019	–		2 478 743	12%
Paraffin	115 992	23 661	11 199	–	–	23		150 874	1%
Liquid petroleum gas	36 982	36 982	73 965	–	–	–	–	147 929	1%
Heavy furnace oil	–	9 288	107 286	–	–	–	–	116 574	1%
Coal	708	37	471 335	–	–	–	–	472 080	2%
Natural gas	–	–	–	–	–	–	–	–	0%
Jet fuel	–	–	–	738 126	–	–	–	738 126	3%
Aviation gasoline	–	–	–	1 975	–	–	–	1 975	0%
International marine	–	–	–	531 666	–	–	–	531 666	2%
Total	**4 752 490**	**5 487 715**	**2 261 431**	**6 974 396**	**503 635**	**217 630**	**–**	21 282 238	–
Percentage of total	**22%**	**26%**	**11%**	**33%**	**2%**	**1%**	**5%**	100%	–

As noted in the initial overview, electricity consumption and related electricity-dominant sectors contribute substantially more to GHG emissions than does the transport sector, despite this sector consuming more energy in calorific value.

When considering emissions over time, Cape Town has been witnessing a decline in emissions levels from 2007, despite an absolute increase in energy consumption.

Figure 112: Crabo en imibomas eoergs mburyec : C, e pbT oc1w01*

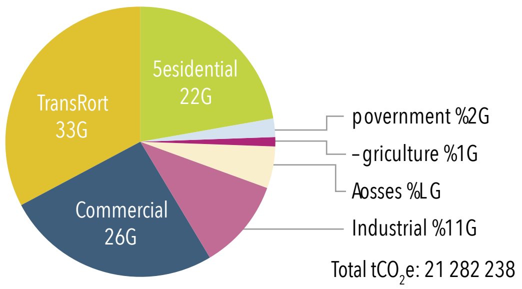
* Including aviation, international marine and electricity losses (electricity losses included in the electricity value)



Source: City of Cape Town, Eskom, Province, SAPIA.

Figure 13: Carbon emissions by sector, Cape Town, 1201*

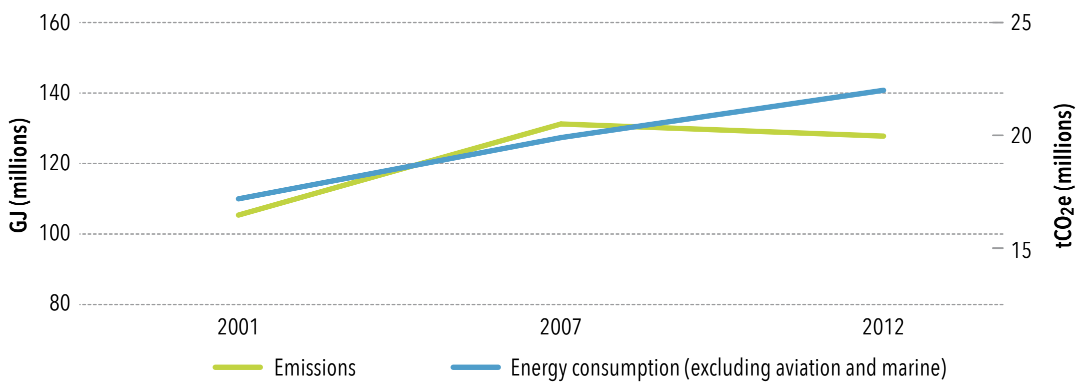
* Including aviation, international marine and electricity losses



Source: City of Cape Town, Eskom, Province, SAPIA.

When considering emissions over time, Cape Town has been witnessing a decline in emissions levels from 2007. This reduction is in part associated with adjustments to carbon emission factors particularly with coal and, by extension, electricity. Cape Town has also seen a decrease in electricity consumption post-2007/8. This has enabled the City to achieve an absolute emissions level reduction off the 2007 base year figures, despite an absolute increase in energy consumption.

Figure 24: Energy-related GHG emissions and energy consumption, Cape Town, 2001–2012



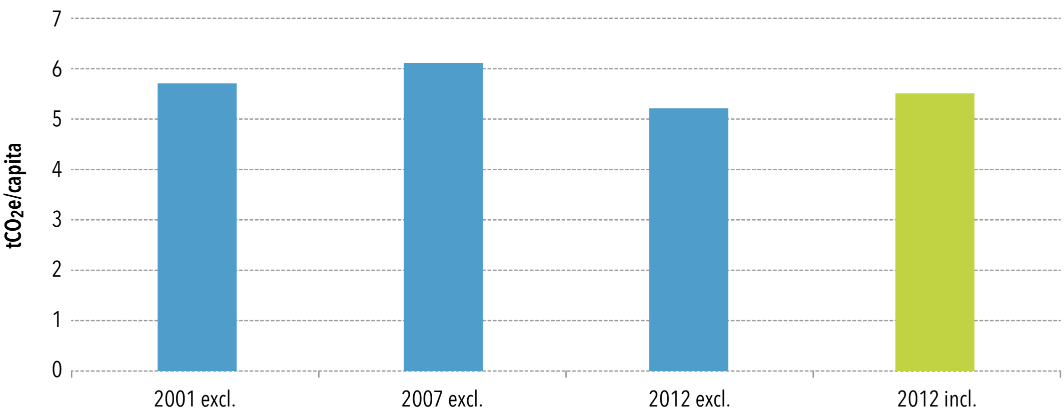
Source: City of Cape Town, DoE, Eskom, SAPIA, SEA, Stats SA.

Emissions per capita are a common global indicator of emissions levels for a country or city. For purposes of comparison over time, the figures below exclude aviation and international marine fuels, as these were not available for 2001 and not yet reliable post-2001 (These fuels are included in 2012 'inclusive' figures for purposes of accurate 2012 totals). Cape Town saw emissions per capita drop from 5,7 tCO_2 capita in 2001 to 5,21 tCO_2/capita in 2012, excluding marine and aviation fuels. The official figure (including all fuels) for Cape Town energy-related emissions for 2012 is 5,55 tCO_2 capita.[16]

Table 24: Energy, carbon emissions and related intensities over time, Cape Town, 2001–2012

	2001 excl.	2007 excl.	2012 excl.	2012 incl.
Energy (GJ)	109 311 370	127 595 550	141 095 151	158 685 055
Emissions (tCO_2e)	16 502 801	20 550 172	20 010 470	21 282 238
Population	2 892 243	3 374 572	3 837 414	3 837 414
Emissions intensity (tCO_2e/capita)	**5,71**	**6,09**	**5,21**	**5,55**

Figure 25: Carbon emissions per capita, Cape Town, 2001–2012 (excluding and including marine and aviation)



Source: City of Cape Town, DoE, Eskom, SAPIA, SEA, Stats SA.

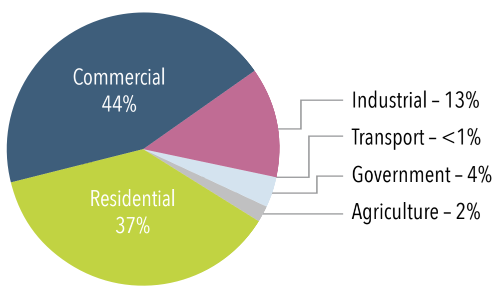
The reduction in per-capita emissions levels is attributable to emission factor changes, the drop in electricity consumption in Cape Town, alongside population growth amongst lower-income (and less energy-intensive) groups.

The total number of customers to whom the City distributes electricity increased by 23 687 between 2006 and 2013, despite a 161 618 501 kWh reduction in total electricity consumption over the same period.

5.4 ELECTRICITY DISTRIBUTION BUSINESS OVERVIEW

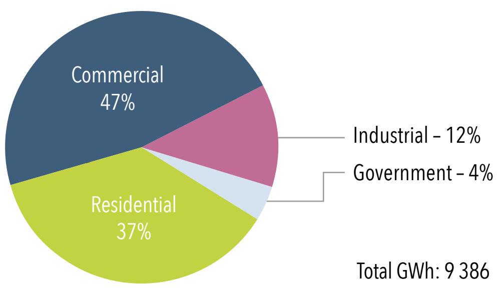
The transport sector dominates Cape Town's energy profile and is analysed as a stand-alone sector. The remaining sectors – residential, commerce and industry – are predominantly reliant on electricity as their energy source. Each sector is studied in the detailed analysis of Cape Town's energy demand by sector. An overview of electricity as a sector itself, particularly as it relates to the municipal distribution business (distributing 75%[17] of all demand), is provided here.

Figure 26: Electricity consumption by sector (municipal and Eskom distribution), Cape Town, 2012



Source::City:of:Cape:Town:Electricity:Services:Department,:Eskom.

Figure 27: Electricity consumption by sector (municipal distribution only, excluding losses), Cape Town, 2012



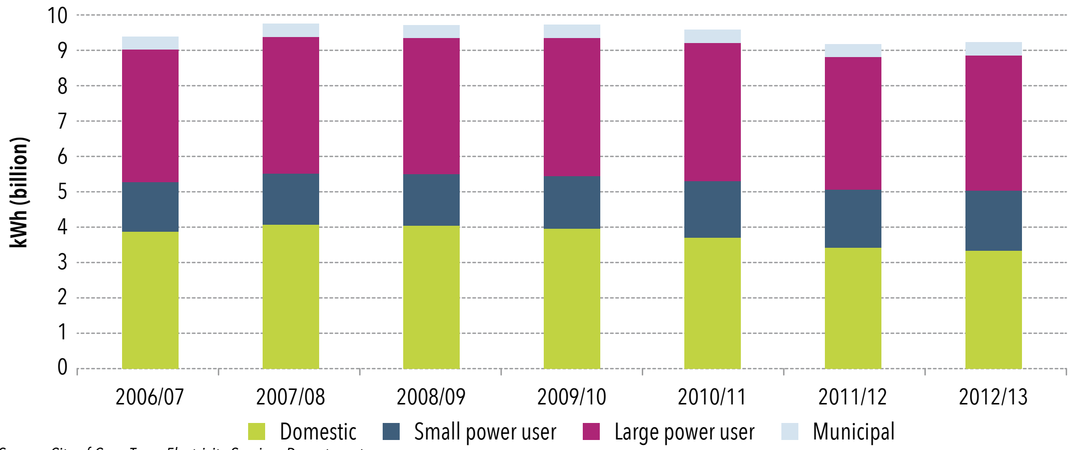
Source: City of Cape Town Electricity Services Department.

The total number of customers to whom the City distributes electricity increased by 23 687 between 2006 and 2013, despite a 161 618 501 kWh reduction in total electricity consumption over the same period (measured off a 2007 base year). This drop is even more sizeable as consumption continued to increase into 2007 – between 2007 and 2013, there was a 519 203 410 kWh reduction in demand. The majority of the new customers are residential.

An entirely new situation has arisen since 2007. Electricity growth first levelled and has since declined, whereas economic growth has continued to grow.

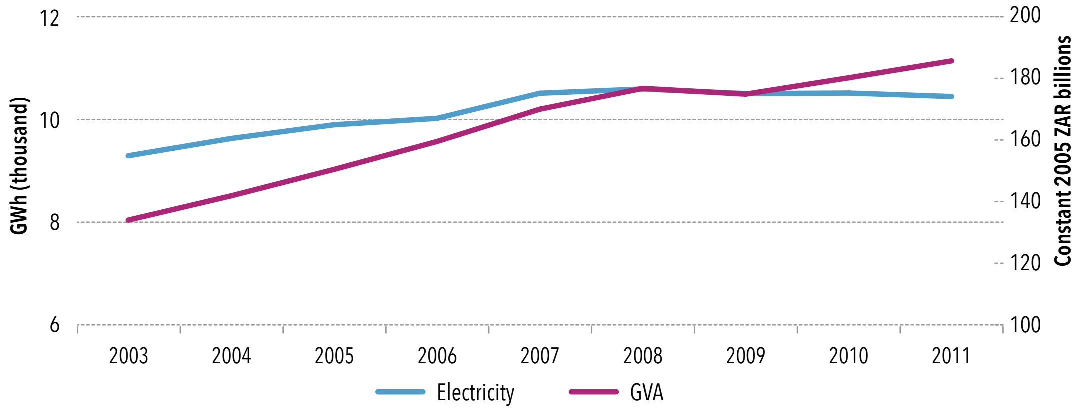
16. Improved levels of data-gathering often result in GHG emissions per capita increasing. Here we see a decline despite improved data-gathering, which reinforces this positive outcome. Much of this is attributable to emission factor changes.
17. Eskom distribution accounts for some 25% of total distribution and the volumes per sector align closely with that of the City, bar slightly more to agriculture and slightly less to commerce.

Figure 28: Change in City of Cape Town electricity sales by tariff over time



Source: City of Cape Town Electricity Services Department.

Figure 29: Change in City electricity sales relative to economic performance (in 2005 real terms) over time

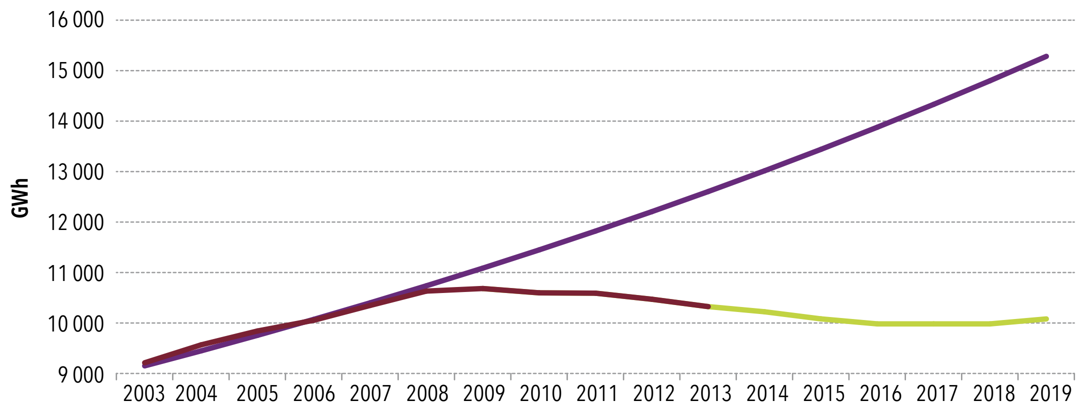


Source: City of Cape Town Electricity Services Department, Quantec.

Data indicate that Cape Town's economy and society have become more energy efficient. Fewer units of electricity were used to produce a unit of economic value in 2011 than in 2001.

The graphic below, provided by the City's Electricity Services Department, shows business-as-usual demand projections against actual demand. The challenge for planners is to develop a much greater level of understanding of electricity demand patterns and elasticity of demand.

Figure 30: City of Cape Town electricity sales forecast vs actual over time

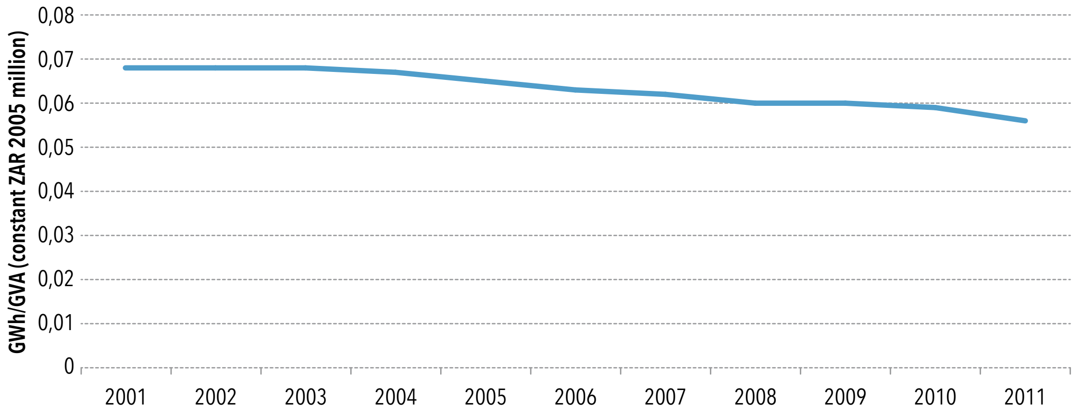


	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Actual	9 134	9 491	9 768	9 982	10 278	10 565	10 616	10 530	10 523	10 402	10 255	–	–	–	–	–	–
New forecast	–	–	–	–	–	–	10 615	10 529	10 523	10 401	10 255	10 152	10 010	9 910	9 910	9 910	10 009
Old forecast	9 072	9 371	9 681	10 000	10 330	10 671	11 023	11 387	11 763	12 151	12 552	12 966	13 394	13 836	14 292	14 764	15 251
Growth	–	3,9%	2,9%	2,2%	3,0%	2,8%	0,5%	-0,8%	-0,1%	-1,2%	-1,4%	-1,0%	-1,4%	-1,0%	0,0%	0,0%	1,0%

Source: City of Cape Town Electricity Services Department, 2014.

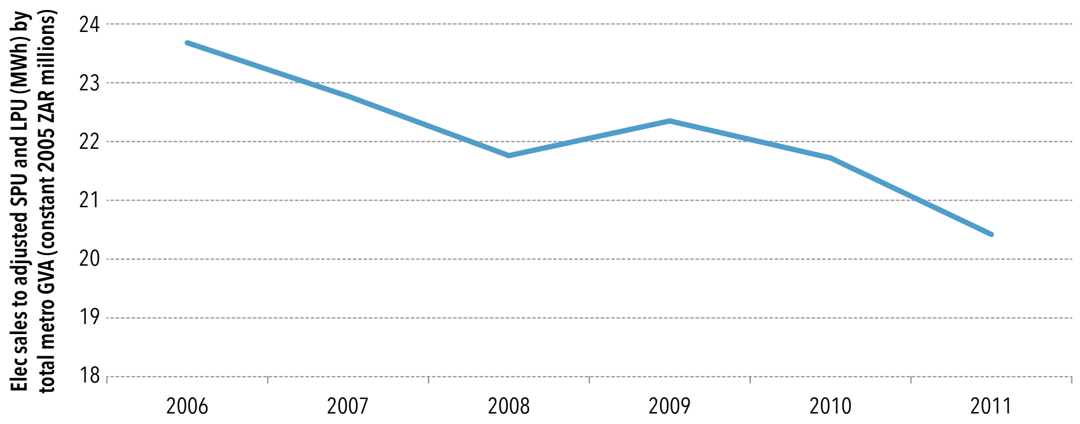
Data indicate that Cape Town's economy and society have become more energy efficient. Fewer units of electricity were used to produce a unit of economic value in 2011 than in 2001. A more detailed analysis of the picture indicates that the greatest consumption reduction has been achieved in the residential sector, followed by the industrial and commercial sectors.

Figure 31: Electricity intensity of the Cape Town economy (in 2005 real terms) over time



Source: City of Cape Town, Quantec.

Figure 32: Electricity intensity of the commercial and industrial sectors in Cape Town relative to economic performance (in 2005 real terms) over time



Source: City of Cape Town, Quantec.

Electricity consumption growth flattened from 2007/8 and started to decline from 2010. The data show that average annual consumption per customer in the small and large power categories has grown slightly, whereas the domestic customer category has decreased by an average of 1 203 kWh per year per customer.

Electricity consumption growth flattened from 2007/8 and started to decline from 2010. The data show that average annual consumption per customer in the small and large power categories has grown slightly, whereas average annual consumption in the domestic customer category has decreased by an average of 1 203 kWh per year per customer.

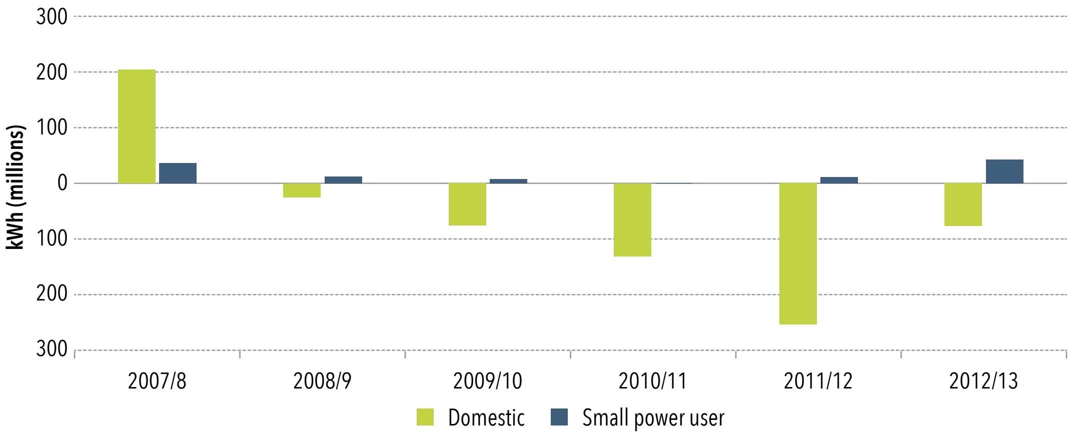
Table 25: Change in City of Cape Town electricity sales and customers over time

Tariff category	Change in customer numbers (2006-2013)	Change in kWh consumption (2006-2013)	Average kWh/ customer (2006)	Average kWh/ customer (2014)	Average electricity intensity change/customer
Total domestic	22 977	-525 620 713	7 042	5 839	-1 203
– Credit (excluding three-phase, cluster)	-24 373	-326 373 616	9 323	8 490	-833
– Prepaid (excluding three-phase, cluster)	47 795	-28 052 588	5 819	5 143	-677
– Three-phase and cluster	-445	-171 194 508	377 356	13 909	-363 447
Total off-peak and small power	964	275 634 614	50 165	57 986	7 820
Total large power	-104	89 968 203	2 454 491	2 697 615	243 123
Total consumer sales	23 687	-161 618 501			

Source: City of Cape Town Electricity Services Department, 2012 data (2014).

It is understood that, in reality, the decrease in the three-phase and cluster categories reflects a shift of these customers into the small or large power user category. What emanates from an analysis of changes in the residential and commercial sectors (with tariff categories of domestic and small power users adjusted so that the three-phase and cluster consumption is brought back into the residential sector) is that there was a sizeable growth in residential (domestic) demand in 2007/8, followed by a rapid demand drop from 2008 to 2011, which started to level out in 2012. This probably reflects the elasticity of demand in the residential sector in response to a combination of price increases and prepaid metering installations. The commercial sector shows a flattening of demand from 2007 to 2012, with a slight increase in the 2012/3 financial year.

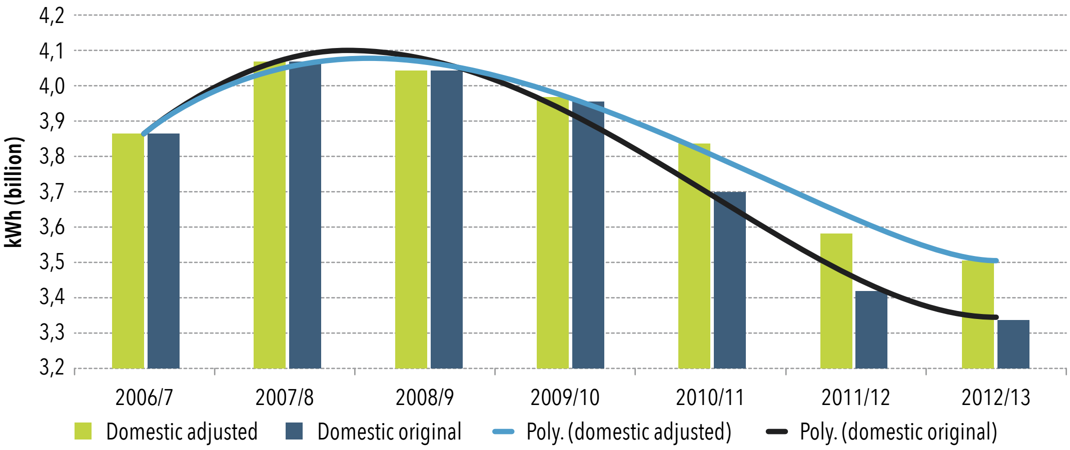
Figure 33: Year-on-year change in City of Cape Town electricity sales by tariff category, adjusted to reflect three-phase/cluster residential back into domestic tariff, over time



Source: City of Cape Town Electricity Services Department, SEA.

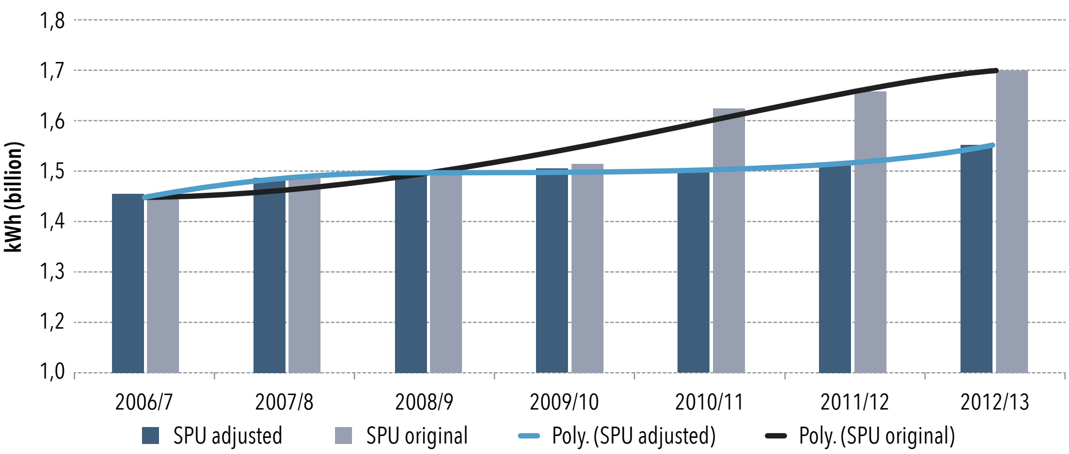
Figure 34: City of Cape Town electricity sales by domestic tariff category, adjusted to include three-phase/cluster residential shifted to the small power user tariff category from 2009/10

There was a sizeable growth in residential (domestic) demand in 2007/8, followed by a rapid demand drop from 2008 to 2011, which started to level out in 2012.



Source: City of Cape Town Electricity Services Department, SEA.

Figure 35: City of Cape Town electricity sales by small power user tariff category, adjusted to exclude three-phase/cluster residential shifted out of domestic tariff category from 2009/10

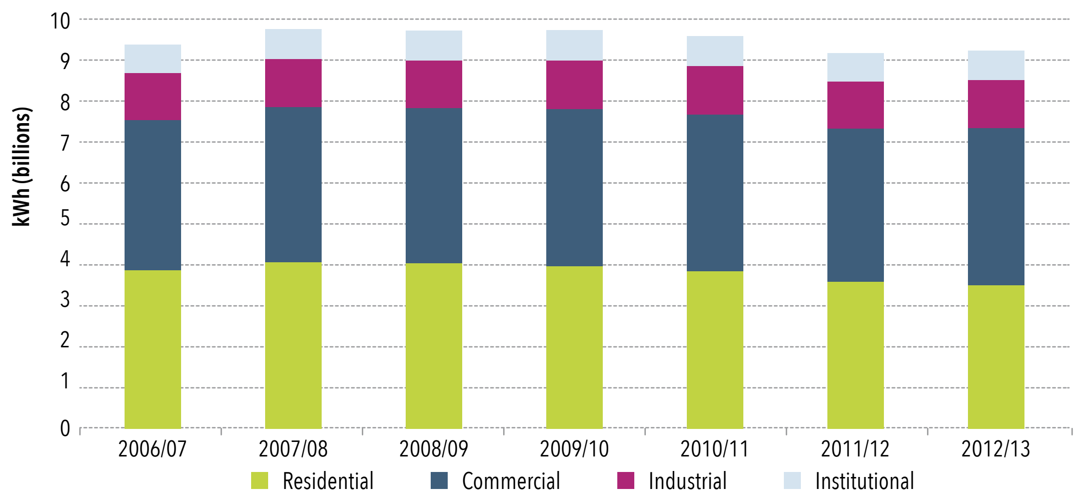


Source: City of Cape Town Electricity Services Department, SEA.

Drawing on an analysis of top customers, the large and small power user categories can be divided into commercial and industrial sectors.[18] The following figures illustrate changing electricity consumption by sector over time.

18. Consumption is allocated on the basis of a detailed analysis (in 2010) of the top 1 500 City customers. This work was done by Caroline Martin drawing on 2006/7 data, so it is fairly dated. Similar levels of access to the top customer data were not possible in 2014. Gary Ross of the City's Electricity Services Department feels that this apportionment still stands.

Figure 36: Change in City of Cape Town electricity sales by sector over time



Note: The residential/commercial adjustment for the three-phase and cluster categories has not been made here, i.e. the residential sector would actually be slightly higher than reflected here. Source: City of Cape Town Electricity Services Department, SEA.

The overall reduction in electricity consumption due to a reduction in the residential sector and general flattening-out of demand in the other sectors affected total electricity sales. These changes, which are experienced in other South African cities as well, seem to be associated with elasticity of demand in relation to price increases, particularly amongst residential customers (see figure 44), as well as the global recession.

In terms of City of Cape Town electricity sales, the domestic tariff (residential sector) consumption accounts for almost 40% of total electricity consumption. Changes in electricity demand amongst this customer group can have a sizeable impact on total electricity sales for the City.

The reduction in total electricity consumption has substantially slowed down demand forecast growth. System maximum demand sits at around 1 900 MW, where it has been since about 2008. This is far below the business-as-usual projections.

Table 26: Proportional breakdown of City of Cape Town electricity sales by tariff

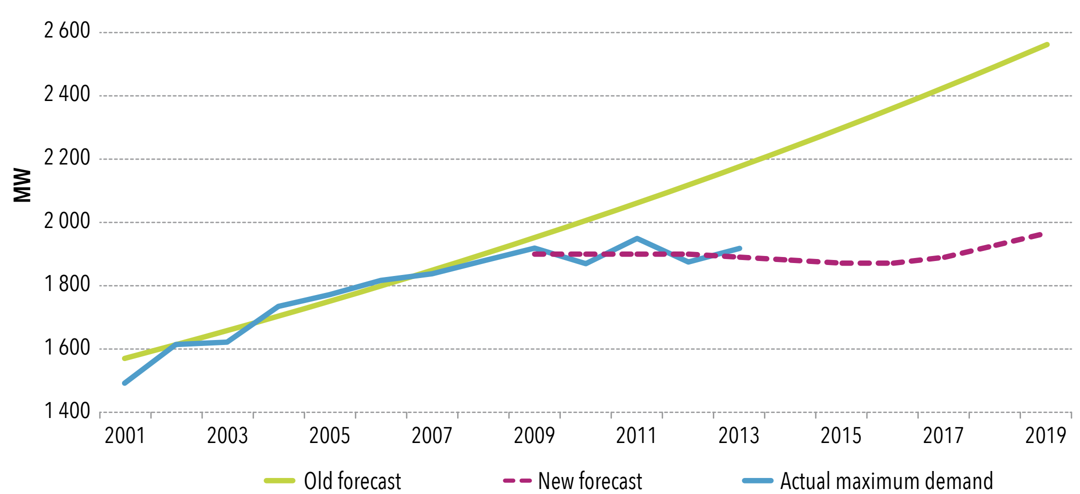
Tariff category	2007	2012
Total domestic	43%	39%
– Credit (excluding three-phase and cluster)	15%	12%
– Prepaid (excluding three-phase and cluster)	26%	27%
– Three-phase and cluster	2%	0%
Total off-peak and small power	16%	19%
Total large power	41%	43%

Source: City of Cape Town Electricity Services Department.

System maximum demand

The reduction in total electricity consumption has substantially slowed down demand forecast growth. System maximum demand sits at around 1 900 MW, where it has been since about 2008. This is far below the business-as-usual projections.

Figure 37: City of Cape Town electricity maximum demand over time



Source: City of Cape Town Electricity Services Department.

5.5 CAPE TOWN BENCHMARKED

It is useful, though often challenging, to benchmark Cape Town against other local and global cities. In 2012, the Economist Intelligence Unit, funded by Siemens, undertook a global study of 'green cities'. The study looked at some 150 global cities (approximately 20–30 per continent) and provided the benchmarking averages outlined below.

Table 27: Global Green City Index averages, 2012

Indicator	United States and Canada	Europe	Asia	Latin America	Africa	Cape Town
Population density in cities (people/km^2)*	3 100	3 900	8 200	4 500	3 500	1 178
Average city population (million)	1,4	2,5	9,4	4,6	3,9	3,8
Average GDP/capita (USD)**	46 000	38 500	18 600	11 100		4 399
CO_2/capita (metric tonnes)	14,5	5,2	4,6			5,2
Modal split (share workers using private vehicles to work)	87%	63%				42%
Waste production (annual kg per capita)		511	375	465	408	522
Share of waste recycled	26%	18%				12%

** Cairo taken out as a far outlier.*
*** Cape Town values for 2012 and at exchange rate of 11 ZAR/USD. Values for study regions mostly 2010; Asia 2008-2009 (Siemens, personal communication, 2015).*
Source: Economist Intelligence Unit/Siemens, 201.2

Cape Town has low densities compared to other cities across all global regions. This makes public transport development enormously challenging. At the same time, the majority of Cape Town residents (58%) rely on public transport. Experts note that it is very difficult to get commuters out of private vehicles and back into public transport once the modal switch has been made. This means it is extremely important for the City of Cape Town to upgrade and enhance public transport in the city, thus retaining current public transport users. Cape Town's emissions levels are on a par with Europe's and slightly higher than Asia's. This indicates the pressure Cape Town will be under to reduce emissions in a carbon-constrained world. Cape Town waste levels are relatively high, but it is positive that the City has minimisation initiatives under way and is able to record these efforts.

South Africa falls into the top ten countries in the world in energy use per unit of economic value generated. Cape Town – with its financially oriented economy – ranks lower than this. It is still high by global terms, however, ranking higher than both the United States and Brazil.

Table 28: Global energy intensity comparisons

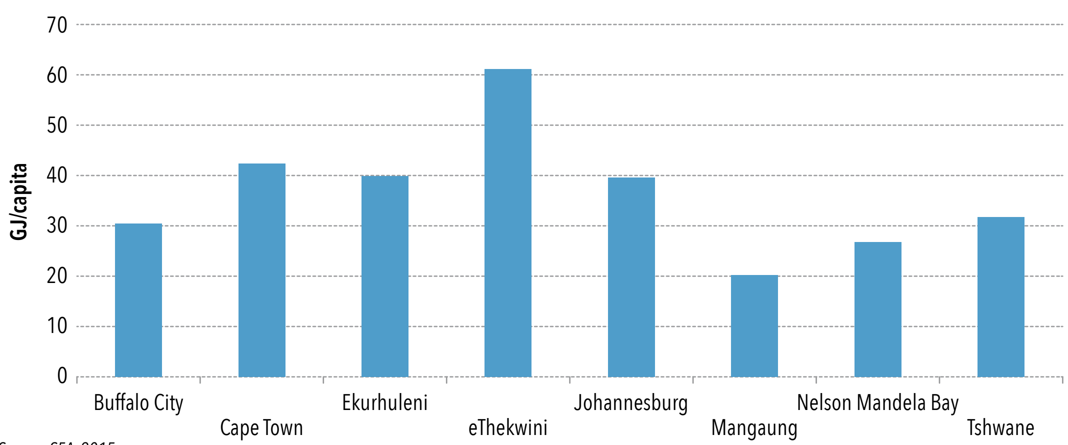
Energy intensity	koe/USD (2005 real)
South Africa	0,276
China	0,261
Cape Town (2012)	0,225
United States	0,158
Brazil	0,140
United Kingdom	0,091
Spain	0,096
Germany	0,113
Mexico	0,122

Notes: The unit "koe" stands for kilogrammes of oil equivalent; exchange rate for 2012 Cape Town figure is 11 ZAR/USD.
Source: Global Energy Statistical Yearbook, 2014.

In terms of energy intensity of the economy, comparisons by city were hard to find. When considering national averages, South Africa falls into the top ten countries in the world (i.e. very high levels of energy for every unit of economic value generated). As would be expected, Cape Town – with its financially oriented economy – ranks lower than this. It is still high by global terms, however, ranking higher than both the United States and Brazil.

The *State of Energy in South African Cities* 2015 report collates the most recent energy data for a range of local cities. Cape Town's energy consumption per capita and economic production figures are amongst the highest.[19] However, this may be due to the quality of data available for Cape Town.

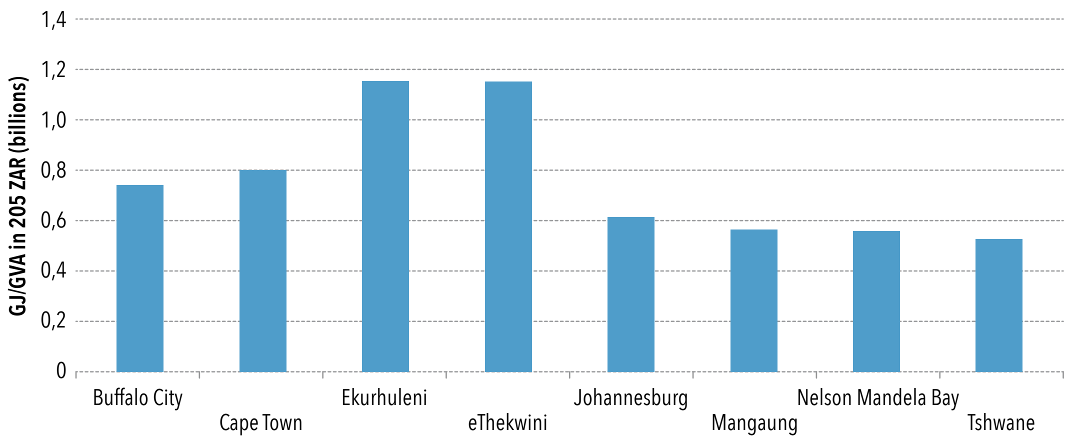
Figure 38: Energy consumption per capita for South African metros, 2012



Source: SEA, 2015.

19. Energy levels for Ekurhuleni seem low, but are based on the most up-to-date data available. One discrepancy is that international aviation fuel data are available for Cape Town and Durban, but not for the Ekurhuleni and Nelson Mandela Bay metros. However, this discrepancy does not have a big impact on comparability.

Figure 39: Energy consumption per economic output for South African metros, 2012



Source: SEA, 2015.

Greenhouse gas emissions per capita are a common global benchmark. The figures below are from different years, but tend not to change rapidly, rendering them a still useful set of comparisons. Emissions figures are greatly affected by fuel sources in a country (for example, Brazil's electricity is largely hydroelectric, with few related global emissions), consumption/wealth levels and climate (for example, the need for heating in winter).

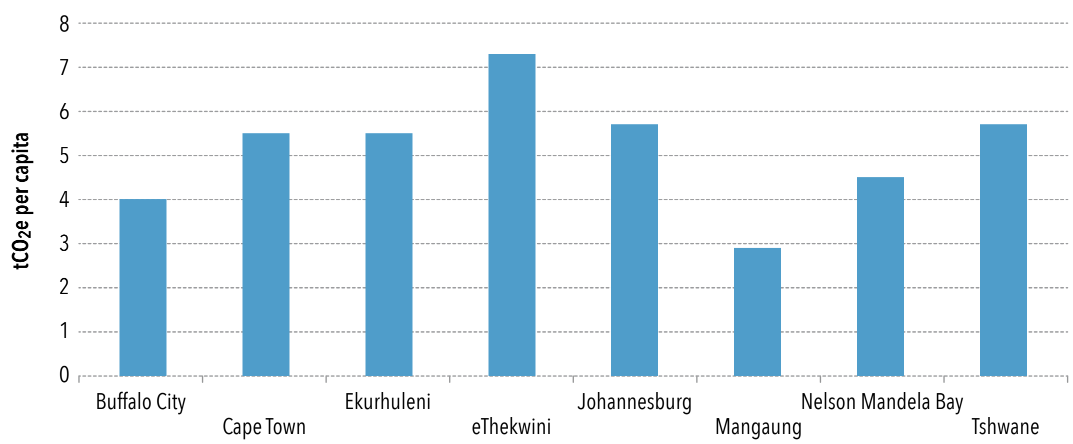
Table 29: Per-capita GHG emissions by city and country

Country	City	tCO_2e per capita	Data year
Argentina	Buenos Aires	3,8	2000
Australia	Sydney	20,3	2006
Belgium	Brussels	7,5	2005
Brazil	Rio de Janeiro	2,1	1998
China	Beijing	10,8	2006
Germany	Frankfurt	13,7	2005
Norway	Oslo	3,5	2005
South Africa	Cape Town	5,5	2012
Sweden	Stockholm	3,6	2005
Source: World Bank, 2011.			

In terms of local benchmarking, Cape Town aligns closely with the other major metros of Johannesburg, Tshwane and Ekurhuleni. EThekwini has a higher per-capita footprint, partly due to its large industrial port.

In terms of local benchmarking, Cape Town aligns closely with the other major metros of Johannesburg, Tshwane and Ekurhuleni. EThekwini has a higher per-capita footprint, partly due to its large industrial port.

Figure 40: Energy-related GHG per capita for South African metros, 2012



Source: SEA, 2015.

6 CAPE TOWN **ENERGY DEMAND**

A sustainable energy approach identifies the energy need and strives to meet it with the least possible impact on the environment, while ensuring that all citizens have equitable access to healthy and clean energy services, and that all sectors are catered for.

A sustainable or integrated energy approach identifies the energy need as the starting point for planning an energy system. It then strives to meet that energy need in a manner with the least possible impact on the environment, while ensuring that all citizens have equitable access to healthy and clean energy services. A good demand-side database is necessary to develop energy strategies and evaluate their implementation, and this report works towards the ongoing development of such a database.

Cape Town's energy demand is explored through examining each main energy-consuming sector: residential, commercial, industrial and transport. Although transport relates to each of the other sectors, its particular set of dynamics requires it to be considered as a subsector on its own.

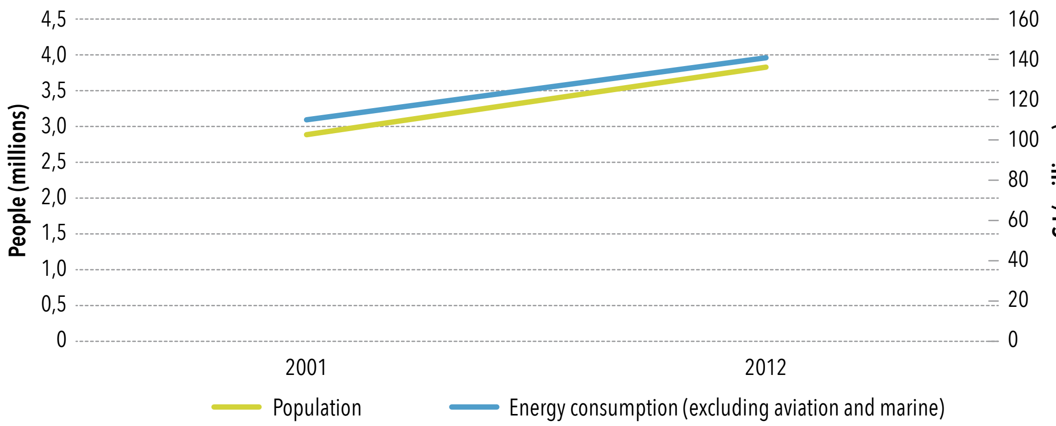
6.1 RESIDENTIAL SECTOR

Understanding household energy use patterns is important for strategy development, both in terms of managing emissions and in terms of welfare. Energy services directly influence human welfare and development through, for example, lights for studying and safety, warmth for health, clean (or not clean) air and the ability to cook and clean.

Households in Cape Town account for 13% of total energy consumption and 37% of total electricity consumption. The population of Cape Town grew by 2,6% between 2001 and 2011. The number of households seems to have grown faster, at around 3,5-4%, with growth in formal and informal households keeping close track of each other (informal households accounted for about 20% of total households in both 2001 and 2011). Although population growth has tracked energy consumption, energy consumption per household has dropped. This may be due to the counting of backyard dwellings, which were previously considered a single unit, along with the front house. Interestingly, this sector's total electricity demand has in fact reduced since 2008, and now stands at below 2006 levels.

Cape Town's energy demand is explored through examining each main energy-consuming sector: residential, commercial, industrial and transport. Although transport relates to each of the other sectors, its particular set of dynamics requires it to be considered as a subsector on its own.

Figure 41: Population and energy growth, Cape Town, 2001–2012

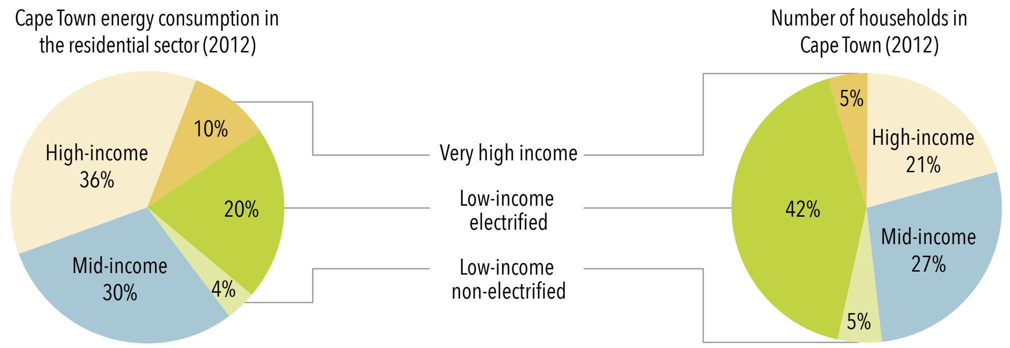


Source: City of Cape Town, DoE, Eskom, SAPIA, SEA, Stats SA.

6.1.1 HOUSEHOLD ENERGY SOURCES AND RELATED DEMAND TRENDS

A disproportionately large amount of energy is consumed by households with high and very high incomes when comparing energy consumption with household numbers. Low-income households, on the other hand, contribute only 24% to overall residential energy consumption, while making up 47% of all households.

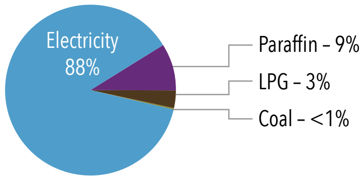
Figure 42: Residential sector: energy consumption vs number of households, Cape Town, 2012



Source: City of Cape Town, DoE, Eskom, SAPIA, Stats SA. *Source: Stats SA.*

The vast majority of households in Cape Town have now been electrified. With 94% of households equipped with electricity (up from 88% in 2001), Cape Town has the highest electrification level of all metros in the country.[20] Electricity comprises 88% of all energy sources used to meet household energy needs, while paraffin and liquid petroleum gas comprise 9% and 6% of residential-sector energy consumption respectively.

Figure 43: Residential-sector energy consumption by energy source, Cape Town, 2012



Source: City of Cape Town, DoE, Eskom, SAPIA.

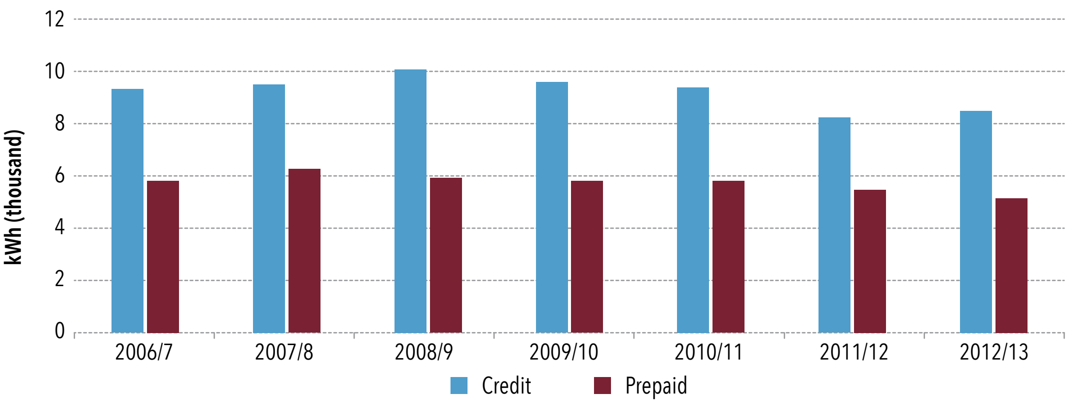
Electricity

Electricity is the major energy source in this sector, comprising 88% of household energy demand. Households, in turn, make up 37% of the total electricity demand in the city (see figure 26, Electricity consumption in Cape Town per sector, 2012 (municipal and Eskom distribution). This sector is of importance to energy planning and management because of the peak timing of its electricity demand. Households consume electricity in concentrated bursts at the start and finish of each working day – and the City and Eskom must have the capacity to supply in this 'peak' demand.

Residential electricity consumption decreased since 2007 from 4,1 GWh in 2007/8 to 3,5 GWh in 2012/13, despite population and household increases witnessed over this time (see figure 34). The 2012/13 consumption figure is even below 2006 levels (3,8 GWh). Demand reduction can be seen amongst both the credit and prepaid customer groupings.

Households make up 37% of the total electricity demand. This sector is of importance to energy planning and management because of the peak timing of its electricity demand – households consume electricity in concentrated bursts at the start and finish of each working day.

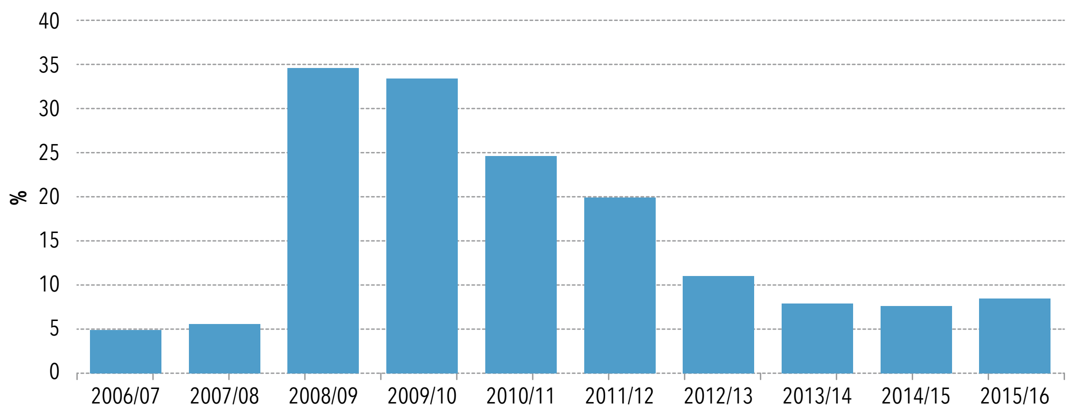
Figure 44: Electricity consumption by City of Cape Town customer on domestic tariffs (credit and prepaid, not three-phase or cluster)



Source: City of Cape Town Electricity Services Department.

This drop in demand is associated with price increases, indicating a degree of elasticity of demand in residential electricity consumption. Other factors that have contributed to the demand reduction include loadshedding as a result of national supply constraints (which started in 2006) and Eskom's associated demand management drive. The City also embarked on an awareness campaign amongst residents, aimed at providing information and support in pursuit of greater household energy efficiency. The expansion of prepaid metering systems may have also enhanced household electricity management.

Figure 45: City of Cape Town electricity tariff increases, 2006–2016



Source: City of Cape Town Electricity Services Department.

20. Stats SA Census 2001 and 2011.

Finally, households may also have been affected by the global recession of 2009.

To a certain extent, the reduction in demand may relate to fuel-switching. Though the overall picture is one of growing dominance of electricity in household energy use, households (low-income and mid to high-income) showed some increases in the use of liquid petroleum gas for cooking between 2001 and 2011, while this fuel source also seems to have been used as a substitute for electricity in meeting the space-heating needs of some mid to high-income households (see figure 47).

Other energy sources: paraffin, liquid petroleum gas and candles

Residential paraffin use constitutes some 72% of total paraffin use in Cape Town.[21] This fuel is used for cooking (in 4% of low-income households), space heating (in 15% of low and mid-income households) and lighting (in 4% of low-income households). Paraffin consumption is almost exclusive to low-income households (see all figures relating to household energy source by end-use application and income group).

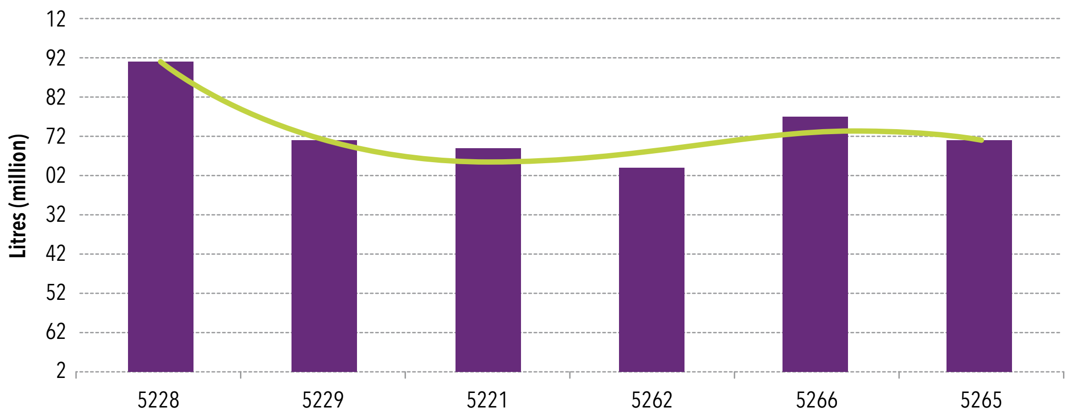
Electrification has resulted in important reductions in household paraffin consumption – from 16% down to 4% of all households using it for cooking, and from 9% down to 4% of all households using it for lighting (see figure 47: Energy sources used for lighting in Cape Town households, 1996–2011). Total paraffin consumption in the city has dropped by 20 million litres per year. This will improve indoor air quality and other risks associated with paraffin use, such as poisoning and fire.

Candle usage for lighting has also dwindled, but is still a factor. This is a concern, as this fuel source is the main cause of the devastating shack fires so often experienced in Cape Town. These fires are enormously costly in terms of human life, physical assets and mental well-being.

Liquid petroleum gas, accounting for 3% of total household energy consumption, is used for cooking and space heating.

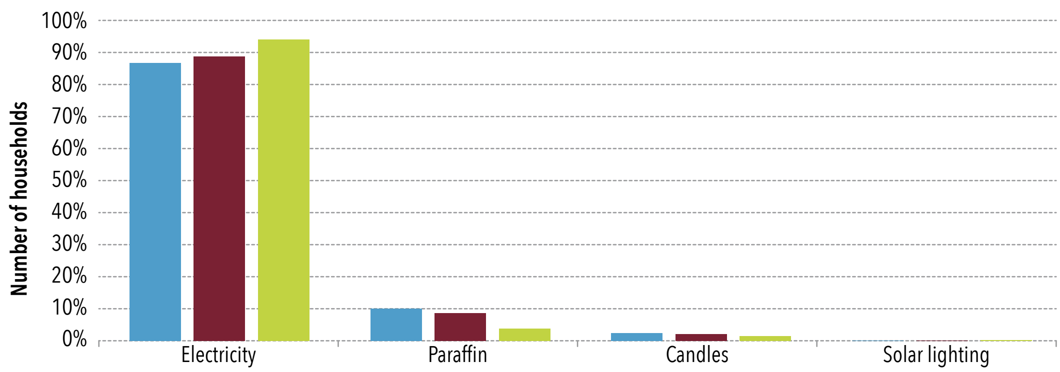
Total paraffin consumption in the city has dropped by 20 million litres per year. This will improve indoor air quality and other risks associated with paraffin use, such as poisoning and fire.

Figure 46: Paraffin consumption, Cape Town, 2007–2012



Source: DoE, SAPIA, SEA.

Figure 47: Energy sources used for lighting in households, Cape Town, 1996–2011



	Electricity	Paraffin	Candles	Solar lighting
1996	86,8%	10,1%	2,4%	0,0%
2001	88,8%	8,7%	2,1%	0,1%
2011	94,0%	3,8%	1,5%	0,2%

Source: Stats SA.

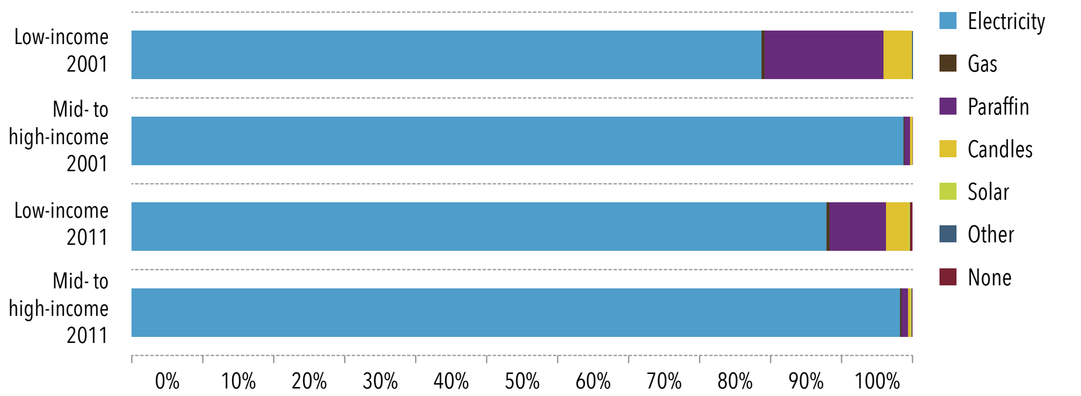
21. Cape Town Energy Futures (LEAP) model, 2015, SEA.

6.1.2 END-USE ENERGY APPLICATIONS

Lighting

Within households, electricity is the major energy source used for lighting, although some households still use paraffin and candles for this purpose (see figure 47). Despite great reductions, the presence of any candle or paraffin lamp poses an enormous fire risk and health hazard for households. Solar lighting is still in its infancy, but may emerge as a new, safe source of lighting.

Figure 48: Fuels used for lighting by income group, Cape Town, 2001 and 2011



Source: Stats SA.

Electricity replacing paraffin for cooking in low-income households is a very positive development. However, it pushes up the need for peak power generation capacity.

Energy efficient light bulbs have successfully penetrated high-income households. However, amongst middle and low-income households, there has been a rebound effect since the Eskom roll-out of free efficient bulbs (compact fluorescent lights). (Eskom stated that an 80% penetration had been achieved in Cape Town.) Rebound occurs due to the traditional tungsten bulbs being a far cheaper replacement option when the energy-efficient bulb reaches the end of its useful life.

Table 30: Most frequently used lighting/bulb types by income level, 2014

	Regular bulbs	Energy efficient compact fluorescent bulbs (CFLs)	Energy efficient light-emitting diodes (LEDs)
High-income	23%	70%	20%
Middle-income	64%	36%	–
Low-income	72%	28%	–

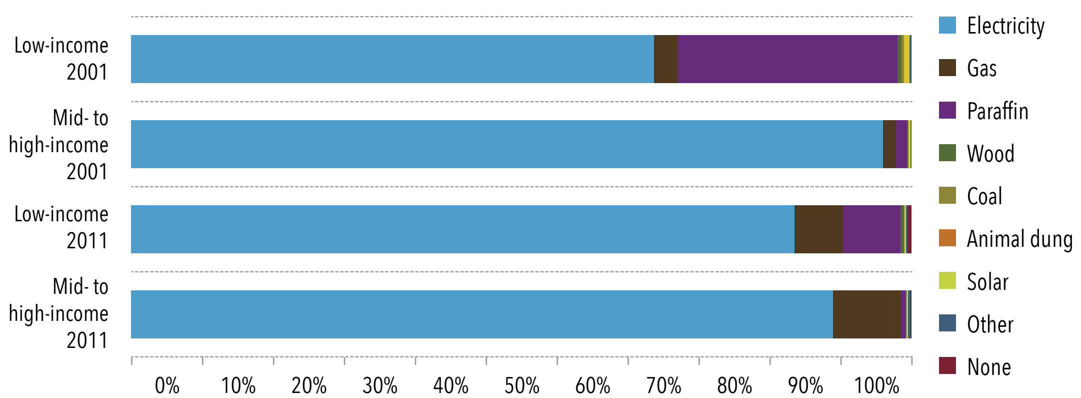
Source: Mthenthe Household Energy Use Survey draft report, 2014.

Cooking

The major source of energy for cooking is electricity. Gas for cooking is used across all income bands, but consumption levels are still low compared with electricity. Paraffin is also still used within low-income bands, though it is declining. Comparisons between 2001 and 2011 figures show a marked increase in low-income households using electricity for cooking.

As electricity replaces paraffin, this is a positive development. However, this has a potentially substantial impact on peak demand, which is costly for the City and the country as it pushes up the country's need for peak power generation capacity. Both high and low-income households also seem to increasingly use gas for cooking. This is a lower-carbon fuel and more efficient for cooking. There is significant benefit in diversification away from electricity for energy services that drive peak demand.

Figure 48: Fuels used for cooking by income group, Cape Town, 2001 and 2011

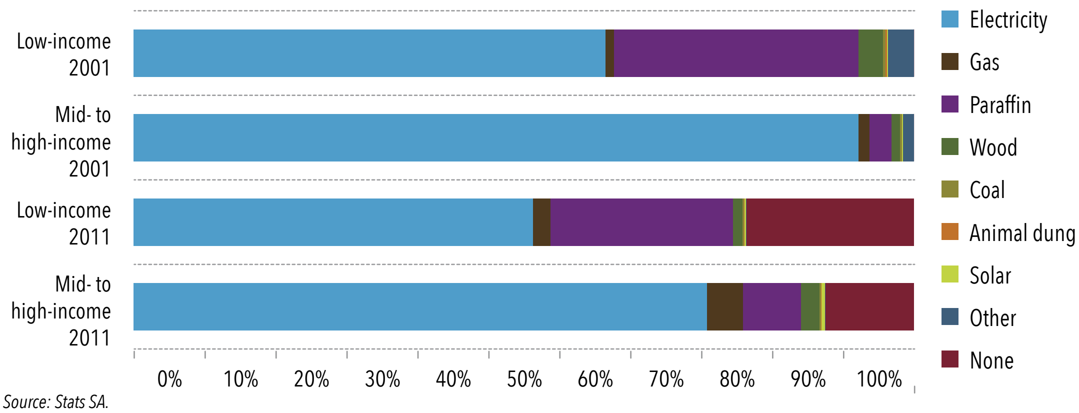


Source: Stats SA.

Space heating

Although still electricity-dominated, mid to high-income household energy usage in Cape Town has moved towards a greater use of gas, paraffin and wood for space-heating purposes (presumably in response to rising electricity prices). Paraffin still plays a sizeable role in poorer households. Paraffin represents an ongoing threat to households, as it results in indoor air pollution and condensation, leading to wet, damp, polluted conditions, which negatively affect respiratory health.

Figure 50: Energy sources used for space heating by income group, Cape Town, 2001 and 2011



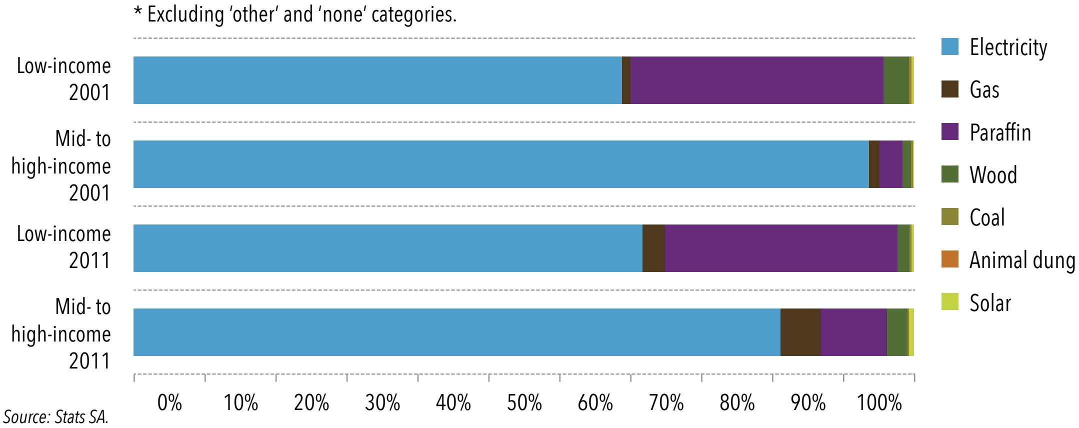
Source: Stats SA.

Stats SA did not record the option of 'none' in 2001. In the 2011 data, the number of low-income households in particular who recorded 'none' for space heating could be due to poverty and may indicate 'supressed demand'. In other words, energy use may rise as incomes rise and households are able to afford to warm their homes. Of course, cold houses also have health implications.

When looking at fuel consumption for space heating, excluding 'other energy services' or 'no energy services' as options, it seems that although electricity dominates, poor households still rely heavily on paraffin to meet their space-heating needs. However, there has been an increase amongst all households, and in particular higher-income households, in the use of liquid petroleum gas for space heating.

Figure 51: Energy sources used for space heating by income group, Cape Town, 2001 and 2011*

* Excluding 'other' and 'none' categories.



Source: Stats SA.

Poor households in Cape Town live in poorly built, thermally-inefficient housing. This means that houses are cold in winter and hot in summer. In addition, the lack of ceilings in older homes results in condensation and consequent dampness inside the house, posing health risks to residents.

6.1.3 ENERGY SERVICES FOR SUSTAINABLE DEVELOPMENT

Energy efficiency/thermal efficiency

Poor households in Cape Town live in poorly built, thermally-inefficient housing. This means that houses are cold in winter and hot in summer. In addition, the lack of ceilings in older homes results in condensation and consequent dampness inside the house, posing health risks to residents. The thermal efficiency[22] of housing has long been considered an important means to meet an energy service need. Many mid to high-income houses are also inefficiently built, reflecting the past era of cheap electricity.

22. Thermal efficiency of housing stock can be used as an indicator of the energy burden on poor households. This "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, *A survey of energy-related behaviour and perceptions in South Africa: The residential sector*, 2012).

The new energy efficiency building regulations (SANS 204, National Building Regulations Part XA) require all newly built housing to be energy efficient. These regulations have also been extended to include government-delivered low-income housing. The City has included ceilings in its housing since 2005 through the Southern Cape coastal condensation subsidy.

No low-income housing stock delivered prior to these regulations and subsidies included ceilings, and retrofitting this stock is a sizeable task. A recent household energy survey[23] indicated that 71% of low-income households within the survey did not have ceilings in their houses, while 100% of wealthy households did.[24]

Solar water heating

Water heating is one of the highest electricity-consuming end uses for households. The majority of mid to high-income households use electric geysers, while electric kettles are mainly used for water heating in low-income households.[25]

The City has seen solar or efficient water heating as a critical element in the transition to more sustainable energy use and has programmes under way to promote the uptake of more efficient water-heating technologies.

Table 31: Municipal programme-led solar water heater penetration in Cape Town[26]

Solar water heaters (SWHs)	2014
High-pressure SWHs installed in Cape Town (cumulative)	25 000
Low-pressure SWHs installed in Cape Town (cumulative)	4 570

A component of the definition of 'energy poverty' is households spending more than 10% of their income on meeting their energy needs.

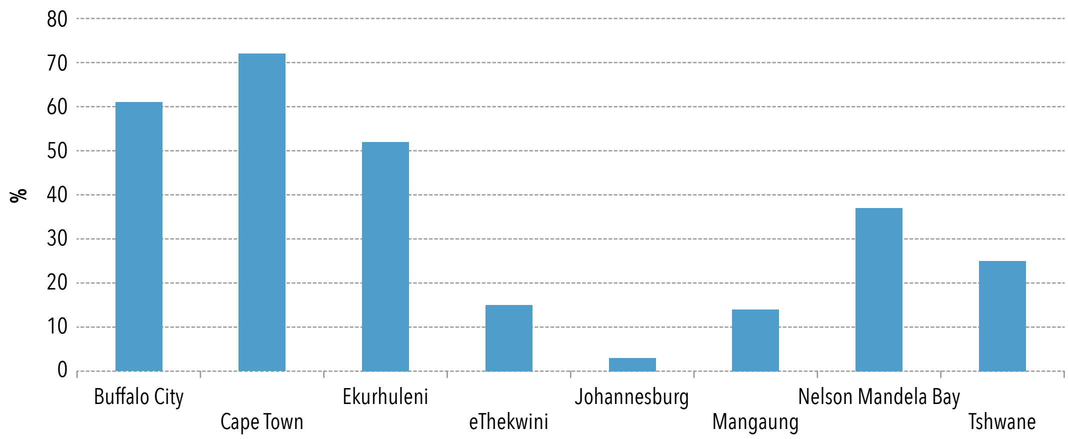
6.1.4 ENERGY POVERTY AND RELATIVE COST OF HOUSEHOLD FUELS

Meeting energy service needs places a disproportionate economic burden on poor households. A component of the definition of 'energy poverty' is households spending more than 10% of their income on meeting their energy needs. A number of surveys in Cape Town point to indigent households spending from 8% to 19%, or even as wide a band as 5% to 25%, of their income on meeting their energy needs. As these households form some 38% of Cape Town's residents,[27] this proportion of households may be categorised as energy poor.

Although prepaid metering means that households 'self-disconnect' when they run out of money (which has social implications), the concomitant technological developments, such as the ability to make electricity purchases via cellphones, appear to have assisted poor households, as they are able to buy very small portions at a time, without being penalised. Studies conducted in Joe Slovo and Delft informal settlements point to a buying pattern of very small top-ups (R10–R20) every second or third day in poor households.

The City has initiated a programme of providing electricity meters to backyard dwellers, supporting households to qualify for the free basic electricity subsidy. This subsidy has been based on consumption levels, and poor households with multiple dwelling units per stand had been unfairly discriminated within this system. Data and measures are still being developed to obtain an accurate picture of subsidy-targeting, but initial indications are that the City leads amongst the country's metros in ensuring that the free basic energy (FBE) target is within indigent residents' reach.

Figure 52: 'Maximum share' of indigent households receiving the free basic electricity grant across South African metros, 2012



Source: SEA, 2015.

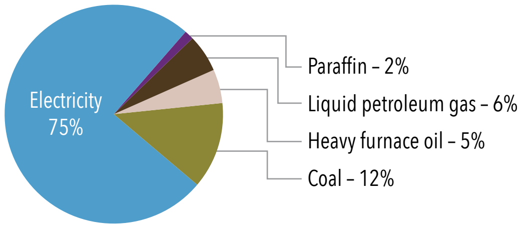
23. Undertaken by Mthenthe Research for SEA, report pending.
24. Mthenthe Research and Consulting Services, *Household Energy User Survey in Selected Areas within Cape Town*, draft report, September 2014.
25. *Ibid*.
26. City of Cape Town Environmental Resource Management Department, 2015.
27. Stats SA Census 2011 data.

6.2. COMMERCIAL AND INDUSTRIAL SECTORS

The commercial sector accounts for 13% of all energy consumption in Cape Town. Industry accounts for 8%.[28]

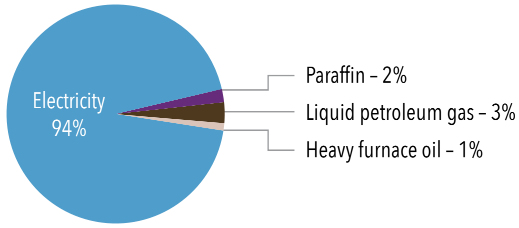
Electricity is the dominant fuel in the commercial and industrial sectors combined (75%), but particularly in commerce (94%). Coal contibutes 12%, liquid petroleum gas 6% and heavy furnace oil 5%. However, when looked at as a sector on its own, the importance of coal in Cape Town's relatively small industrial sector is apparent (33%). Transport-related energy consumption for these sectors is examined as part of the transport sector overview.

Figure 53: Commercial and industrial energy consumption by energy source, Cape Town, 2012



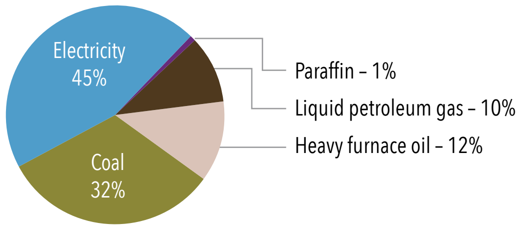
Source: City of Cape Town, DoE, Eskom, SAPIA.

Figure 54: Commercial-sector energy consumption by energy source, Cape Town, 2012



Source: City of Cape Town, DoE, Eskom, SAPIA.

Figure 55: Industrial-sector energy consumption by energy source, Cape Town, 2012



Source: City of Cape Town, DoE, Eskom, SAPIA.

6.2.1 COMMERCIAL AND INDUSTRIAL FUELS AND RELATED DEMAND TRENDS

Electricity[29]

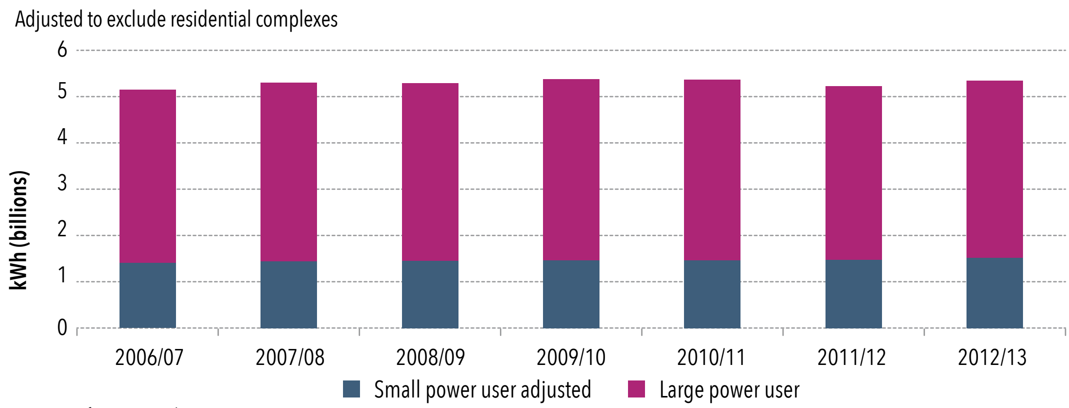
The electricity consumption of the commercial and industrial sectors accounts for nearly 60% of all (City and Eskom-distributed) electricity consumed in Cape Town. It is difficult to apportion electricity consumption to commerce or industry based on sales, which only detail the customer meter category. A detailed study of the top 1 500 customers conducted in 2010[18] provides a generally accepted split of approximately 66:33 between commerce and industry. It is anticipated that rates data, cross-referenced to electricity accounts, will enable a finer allocation in the future.

Commercial end-use consumption[30] is dominated by the lighting, heating and ventilation requirements of office buildings (some 67% of all electricity requirements in the sector). No equivalent end-use analysis has been done for industry.

City electricity sales to the commercial and industrial sector, based on the sales to the small power user (adjusted to exclude residential) and large power user categories, reveal little consumption growth between 2006 and 2012, despite economic growth of 2,5% over the same period.[31]

The electricity consumption of the commercial and industrial sectors accounts for nearly 60% of all electricity consumed in Cape Town, with a split of approximately 66:33 between commerce and industry.

Figure 56: City of Cape Town electricity distribution by small and large power user customer categories, 2006–2012



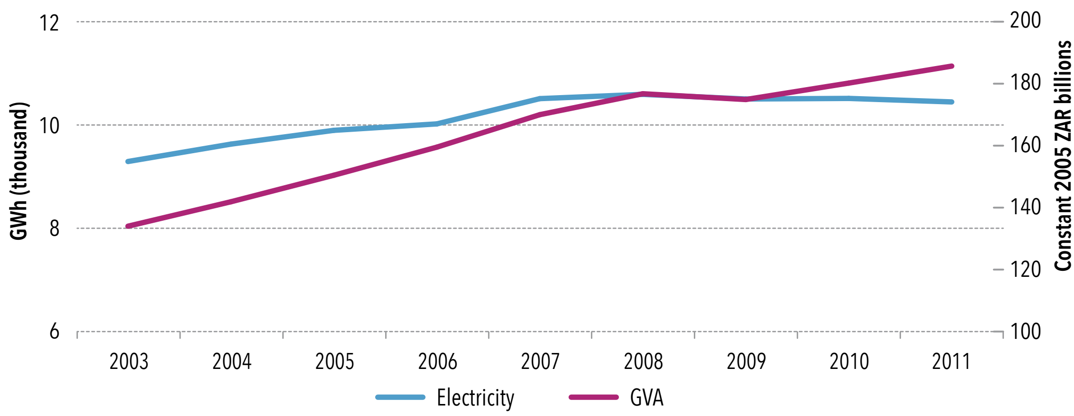
Source: City of Cape Town Electricity Services Department, SEA.

28. The proportion of energy used by these sectors is lower than 2007 figures due to the relative portion of the transport sector, given the inclusion of marine and aviation fuels, and the growth of passenger transport fuel consumption.
29. The analysis presented is based on City of Cape Town distribution figures and does not include electricity distributed by Eskom. This is because Eskom data disaggregated to sector level are available from 2010 only, which does not provide much information on demand trends. As the City distributes 75% of all electricity in the municipal area, trends in sales can be extrapolated as general trends for the sector.
30. Taken from work done for the Cape Town 2011 *State of Energy and Energy Futures* report, City of Cape Town.
31. Quantec, 2014.

Economic growth in the city is starting to show indications of decoupling from energy demand. In other words, economic growth rates are higher than electricity consumption growth and, thus, every unit of electricity used (GWh) is producing greater units of economic value (GVA) than in previous years. This seems to be due to the increasing role of the financial sector in Cape Town (comprising three quarters of the economic sector), which is characterised by low energy consumption and relative elasticity of demand relative to economic output.

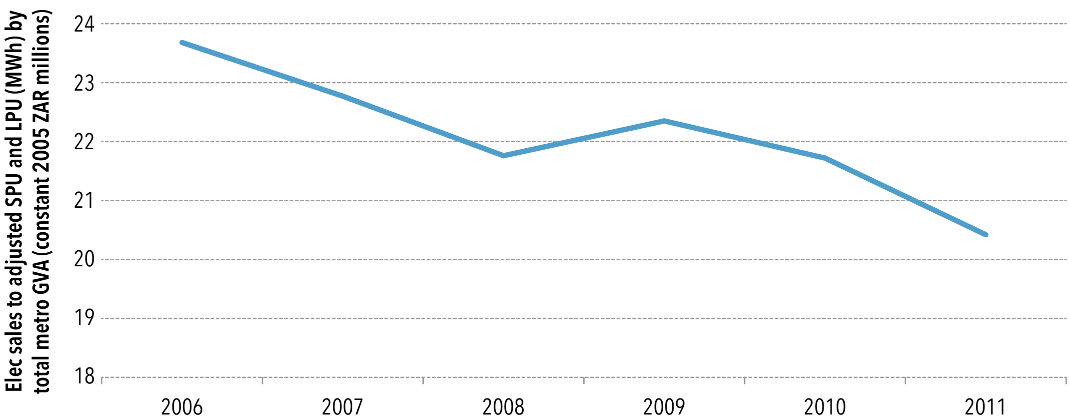
Economic growth rates are higher than electricity consumption growth. Thus every unit of electricity used is producing greater units of economic value than in previous years.

Figure 57: Electricity (City of Cape Town) demand trend relative to economic growth



Source: City of Cape Town Electricity Services Department, Quantec.

Figure 58: Electricity intensity of the commercial and industrial sectors in Cape Town relative to economic performance (in 2005 real terms) over time



Source: City of Cape Town, Quantec.

An overview of the economy indicates finance, trade and transport as the growth-driving sectors. Manufacturing, which is more energy-intensive, is also growing, but more slowly. Greater levels of energy efficiency in commerce and industry surely also contribute to curbing consumption growth. As with households, the commercial and industrial sectors have faced steep electricity price increases during this period and have responded with investments in efficient lighting, heating, ventilation and air-conditioning (HVAC) systems and the replacement of old motors and boilers with more efficient technologies. Anecdotal accounts from the commercial and coal distribution sectors mention fuel-switching, with companies installing efficient coal boilers, for example.[32]

The global economic recession of 2009/10 had a visible impact on economic growth across all sectors. Figure 58: Electricity intensity of the commercial and industrial sectors in Cape Town relative to economic performance (in 2005 real values) over time, shows how a sudden recession can drastically reduce a country's energy efficiency: Economic value per unit of energy input dropped dramatically over this period.

The relative proportions of the primary, secondary and tertiary economic sectors have not changed substantially over time. The tertiary sector dominates the Cape Town economy (representing some 70–80%). The indications are that this sector has been able to achieve energy efficiencies and that economic growth has been able to take place without concomitant growth in energy consumption levels.

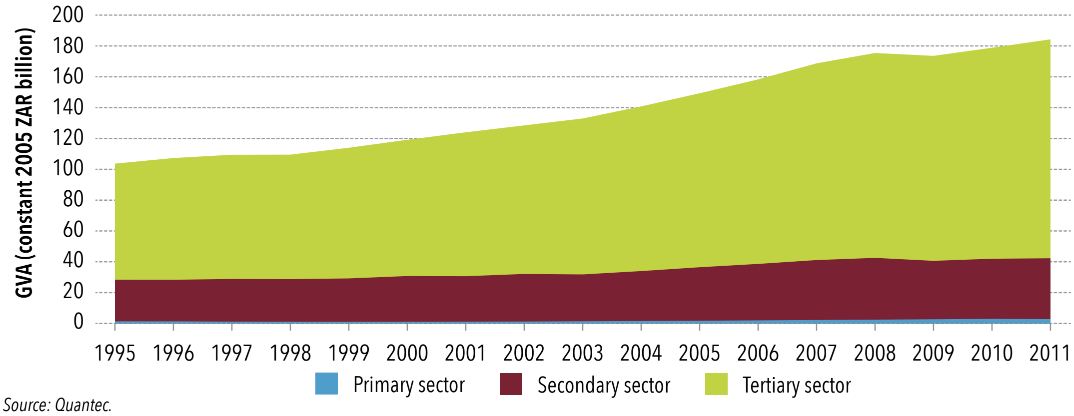
32. Personal communication with laundry operator and private coal distributor, 2014 and 2015.

As with households, the commercial and industrial sectors have faced steep electricity price increases and have responded with investments in efficient lighting, heating, ventilation and air-conditioning (HVAC) systems and the replacement of old motors and boilers with more efficient technologies.

Table 32: Sector proportion of the economy, Cape Town, 2001 and 2011

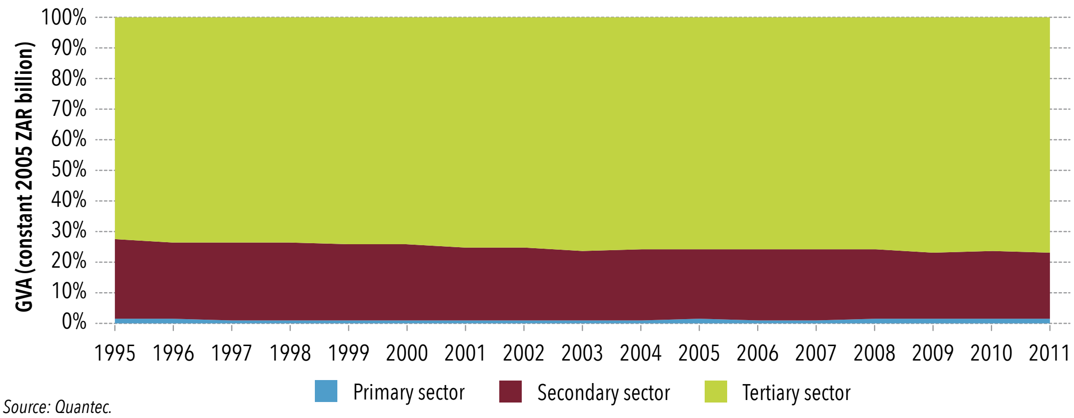
Sector proportion of economy (real ZAR 2005)	2001	2011
Primary	1%	2%
Secondary	24%	21%
Tertiary	75%	77%

Figure 59: Cape Town GVA by sector in constant 2005 ZAR terms, 1995–2011



Source: Quantec.

Figure 60: Portion of Cape Town GVA by sector in constant 2005 ZAR terms, 1995–2011



Source: Quantec.

The lower the energy intensity, the more robust the economy is to price increases and price shocks within the sector. In times of constrained supply (as is being experienced nationally in terms of electricity, but also, to some extent, liquid fuel as the country runs out of refining capacity), greater energy efficiency in the economy can also be seen as the 'freeing-up' of energy (fuel or power) needed elsewhere in the economy.

Other energy sources: coal, heavy furnace oil, paraffin and liquid petroleum gas

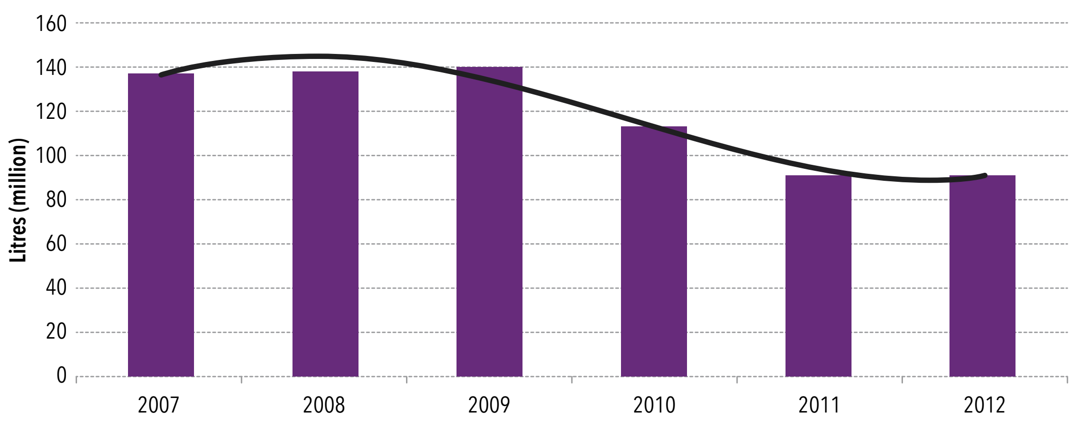
Coal, heavy furnace oil (HFO), paraffin and liquid petroleum gas (LPG) make up the remaining 18% of industrial and commercial energy consumption. These fuels are notoriously difficult to track through to end use.

Coal in Cape Town is used for clay and brick manufacture, as well as for industry boilers and for private and public-sector laundries. A few studies have been conducted on coal,[33] but the most reliable source was felt to be the data obtained from two separate private distributors (representing the lion's share of the market). These indicate coal consumption within the Cape Town area to be in the region of 14 000 tonnes per month, or 168 000 tonnes per year. It is hard to compare this consumption over time due to varying figures and inconsistent data sources.[34] As noted above, distributors have noted a degree of fuel-switching taking place from 2012 onwards due to the increasing electricity prices. This is likely to deepen as the electricity supply constraints intensify.

Analysis of the Department of Energy's liquid fuel data (previously collated by SAPIA) has shown great variability in data quality, which must be kept in mind when considering the following data picture. Three-quarters of all LPG consumption in the city is attributable to commerce and industry (with the remainder being domestic). Consumption of LPG has however decreased. Given that the number of households using LPG for cooking and heating has increased over this period, this decrease may relate to the commercial and industrial sector.

Three-quarters of all LPG consumption in the city is attributable to commerce and industry. Consumption of LPG has however decreased. Given that the number of households using LPG for cooking and heating has increased, this drop must relate to the commercial and industrial sector.

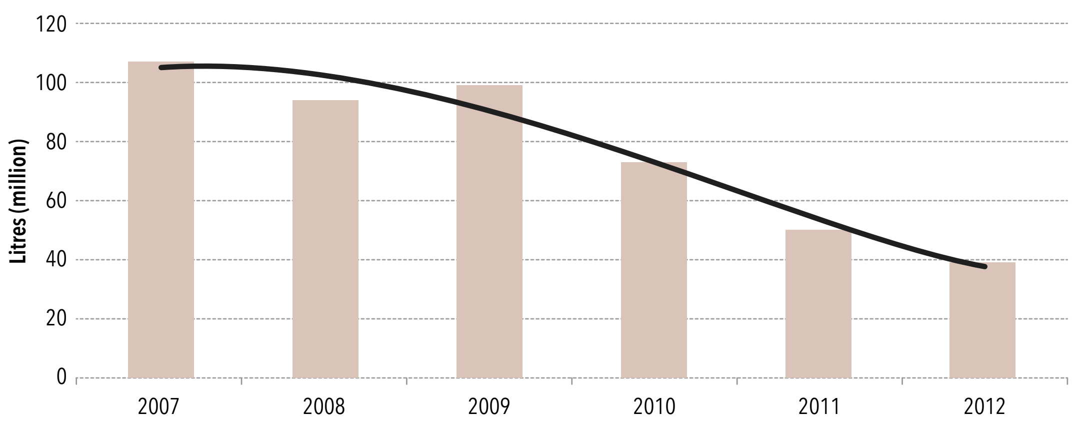
Figure 61: Liquid petroleum gas sales, Cape Town, 2007–2012



Source: DoE, SAPIA, SEA.

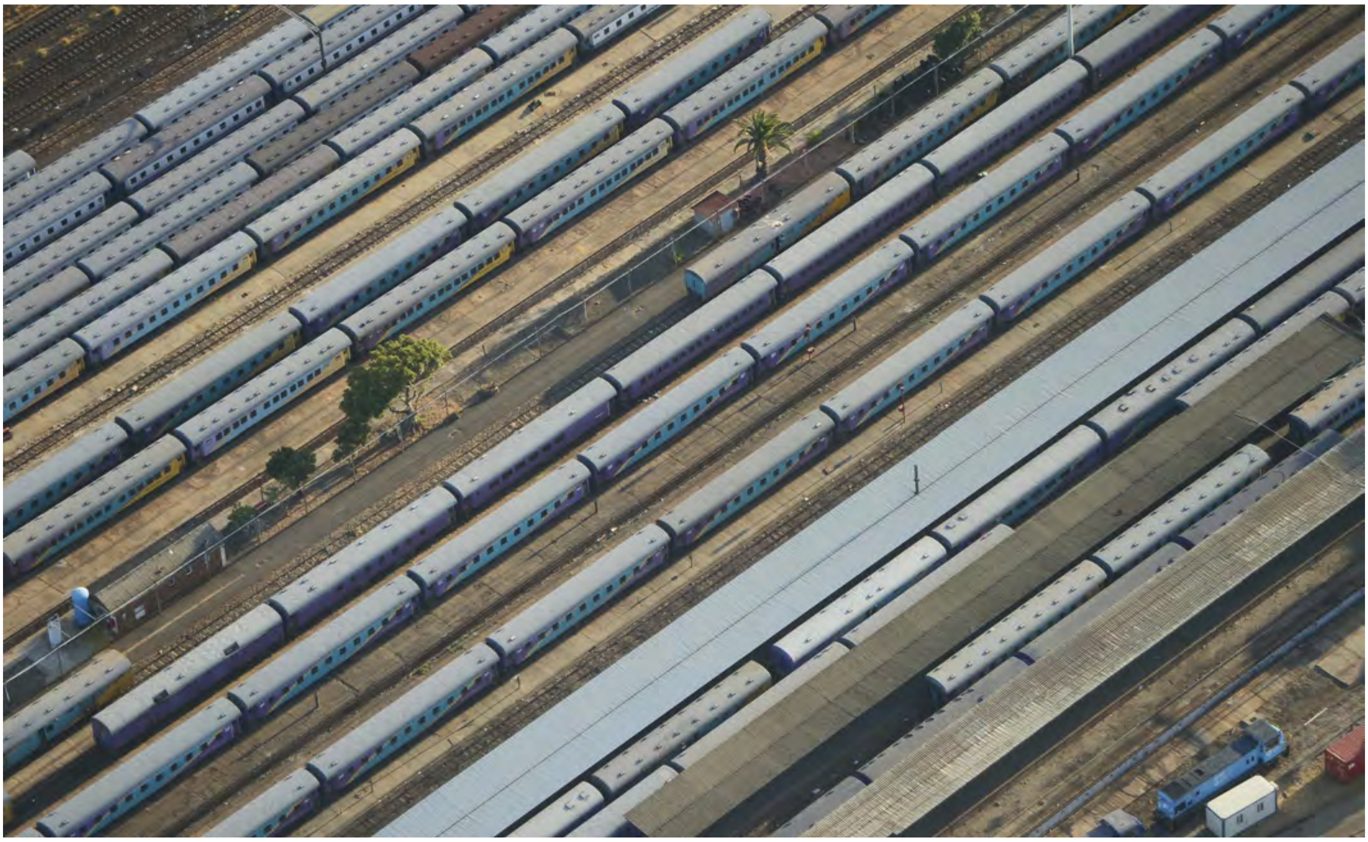
Even larger reductions are seen in HFO consumption in the city, which is a national trend experienced across all South African metros.[35] The drivers behind these trends require further analysis and engagement with the industrial sector.

Figure 62: Heavy furnace oil consumption, Cape Town, 2007–2012



Source: DoE, SAPIA, SEA.

33. Visagie, HJ, *Pre-feasibility report for the importation of natural gas into the Western Cape*, for the Western Cape Department of Economic Development and Tourism, 2013; Hoekman, Paul, unpublished thesis, University of Cape Town, with original data source the Growth and Intelligence Network (GAIN) associated with Stellenbosch University.
34. Consideration was given to using the City's air quality figures, as this would have provided a consistent data source. However, the data were felt to be too far below coal distributor figures to be defensible.
35. Sustainable Energy Africa, State of Energy in South African cities, 2015.



6.3 TRANSPORT AND MOBILITY

Cape Town's transport energy demand is shaped by the urban spatial structure, which is characterised by sprawl (low-density development) and an historical emphasis on road-based transport. The latter, despite recent initiatives to establish an integrated rapid transit system, is perpetuated through a lack of intergovernmental coordination relating to public and freight transport planning. The result is high petrol and diesel consumption and correspondingly high local and global emissions. There is also a decline in other quality-of-life indicators, such as safety (road vehicle accidents are high) and time spent commuting.

Cape Town's transport energy demand is shaped by the urban spatial structure, which is characterised by sprawl – low-density development – and an historical emphasis on road-based transport.

Information gaps still exist relating to freight transport[36] as well as deepening the city's understanding of the impact of its port and airport on its energy consumption, economic development and related emissions profile. Another missing link is data on the electricity consumption of the Metrorail system. Electricity for Metrorail is supplied directly by Eskom to Transnet. Data were not readily apparent within the Eskom customer categories and direct application to Transnet for the data has not yet been made.

Low densities, particularly amongst the mid to high-income areas, urban sprawl and the marginal location of poor communities contribute to non-viability of the public transport system and result in longer and longer commutes. Corridor-led densification can have a sizeable, positive impact on transport-related fuel consumption. Population density in Cape Town increased from 1 178 persons per km^2 in 2001 to 1 563 persons per km^2 in 2011. However, for the most part, this densification is neither planned nor directed and predominantly takes place in township areas rather than close to work opportunities or along designated corridors.

The City of Cape Town's Cape Town Densification Strategy technical report indicates that average densities are not very useful indicators of viable public transport potential; rather, corridor or area-specific densities are required. International benchmarking indicates densities of 25 dwelling units/hectare (du/ha) (or approximately 8 000 persons/km^2) as a minimum for viable public transport operations. Densities in the suburban areas of Cape Town are far below this, ranging from as low as 3,9 du/ha in Durbanville to around 12–15 du/ha in areas such as Lakeside, Bellville and Parklands. Densities in townships and informal areas are far higher (45–100 du/ha), as well as in the more urban areas of Sea Point, Rosebank, Woodstock and Rondebosch (ranging from 40 to 70 du/ha). The City's transport authority, Transport for Cape Town (TCT), and Spatial and Urban Design Development Department are engaged in the promotion of corridor densification in support of public transport.

The advent of new innovations in transport, such as Uber Taxis, using smart technology to bring down the costs of 'private' taxi-based transport, introduces unanticipated approaches to transport, which may see a shift away from large, infrastructure-heavy public transport developments.

36. The organisation GAIN, based at Stellenbosch University, may be an important resource towards boosting the City's freight data. However, as a private entity, their data may not be available for public consumption.

Using baseline figures from the 2007 *State of Energy* report for Cape Town, total energy consumption in Cape Town increased by 10,6% in the ten years from 2001 to 2012, and petrol and diesel consumption grew by 25%.

6.3.1 TRANSPORT-SECTOR ENERGY OVERVIEW

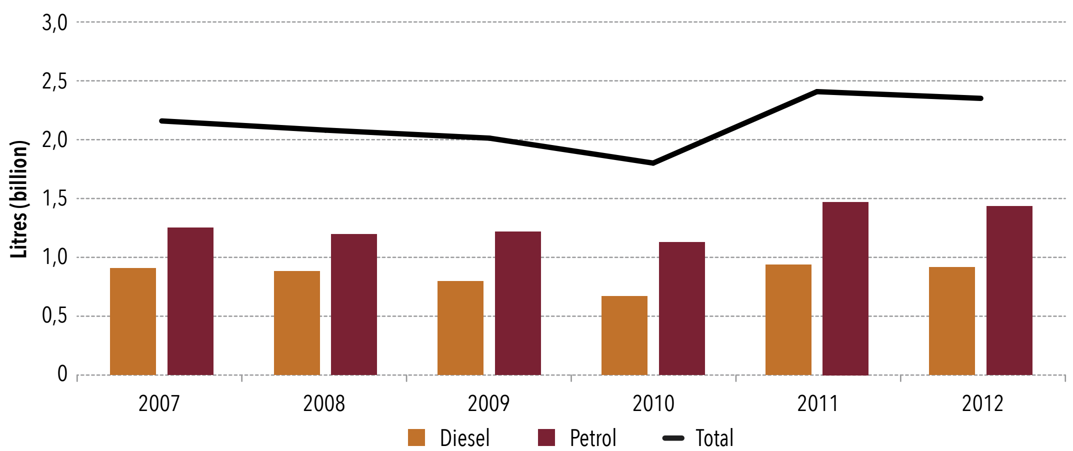
At 64% of total energy consumption, the transport sector now dominates the energy picture of Cape Town. Even if marine and aviation fuels are excluded (as per 2007 totals), the proportion still only slightly reduces to 61% – a large proportional increase from 50% of total consumption in 2007.[37] Petrol consumption in Cape Town alone accounts for 83% of total petrol consumption in the province, despite the city comprising only 73% of the provincial population and 66% of the provincial economy. In terms of global emissions, local transport accounts for only 29% of GHG emissions, although it does contribute substantially to local air pollution.

Transport fuel growth has played a strong role in driving energy consumption. However, differing datasets make growth analysis difficult. Using baseline figures from the 2007 *State of Energy* report for Cape Town, total energy consumption in Cape Town increased by 10,58% in the ten years from 2001 to 2012,[38] and petrol and diesel consumption grew by 25%. However, using a single dataset from DoE/SAPIA, total growth in petrol and diesel consumption between 2007 and 2012 is reflected as 9% in total. The 2007 *State of Energy* report also drew on SAPIA datasets, which have since been adjusted.[39] This is an example of data challenges, particularly for growth analysis. Given the decline in electricity consumption over the same period, overall growth in Cape Town's energy consumption has been led by growth in Cape Town's consumption of transport fuels.

Table 33: Diesel and petrol data, Cape Town, 2007–2012 (comparing data over time)

	2007	2008	2009	2010	2011	2012
Figures as per official national (DoE/SAPIA) dataset 2014 (Ankerlig subtracted from diesel figure)						
Diesel (ℓ)	907 667 230	883 527 859	796 034 717	670 944 742	938 192 086	917 373 531
Petrol (ℓ)	1 251 727 991	1 197 780 368	1 217 083 130	1 130 630 711	1 470 074 258	1 433 710 154
Total (ℓ)	2 159 395 221	2 081 308 226	2 013 117 847	1 801 575 453	2 408 266 344	2 351 083 684
Total diesel (GJ)	34 582 121	33 662 411	30 328 923	25 562 995	35 745 118	34 951 932
Total petrol (GJ)	42 809 097	40 964 089	41 624 243	38 667 570	50 276 540	49 032 887
Total (GJ)	77 391 219	74 626 500	71 953 166	64 230 565	86 021 658	83 984 819
Diesel growth						1%
Petrol growth						15%
Total growth 2007-2012						9%
Figures as per previous official national (DoE/SAPIA) dataset publications as reflected in Cape Town State of Energy reports 2001, 2007						
Diesel (GJ)	27 874 063		30 064 496			34 951 932
Petrol (GJ)	39 392 694		41 620 196			49 032 887
Total	67 266 757		71 684 692			83 984 819
Diesel growth			3,90%			25%
Petrol growth			2,80%			24%
Total growth 2007-2012						25%

Figure 63: Petrol and diesel consumption, Cape Town, 2007–2012



Source: DoE, SAPIA, SEA.

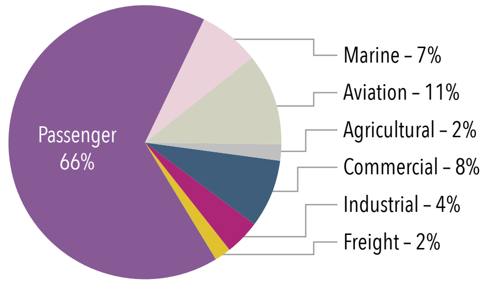
37. Transport typically dominates a city's energy consumption: Mexico City reports transport-sector energy consumption levels of 54% (2004) and Buenos Aires 49% (2000). However, Cape Town's is higher than this. Figures quoted in UN-Habitat *Global Urban Observatory Report*, 2008.
38. Figures excluding marine and aviation fuels for purposes of comparison.
39. Using baseline figures from the first *State of Energy* report for Cape Town (compiled in 2003), the total energy consumption for Cape Town increased by 26,8% in the ten years from 2001 to 2012. Petrol and diesel consumption increased by 37%. These figures also drew on SAPIA/official national datasets.

Based on the most recent national dataset, petrol and diesel consumption declined in the 2007–2010 period, but rose sharply between 2010 and 2011. The year 2011 saw a strong resurgence of consumption of both fuels, but particularly petrol. Sales started to decline again after 2011. Whether these sharp spikes in year-on-year growth are data-related or real is not clear. Small increases in petrol or diesel are happening off a very large base, thus driving overall energy consumption for the city (with these fuels accounting for 53% of all energy in Cape Town).

6.3.2 ROAD-BASED PRIVATE TRANSPORT

National (DoE/SAPIA) data indicate that around 66% of sales relate to passenger transport. Given these figures, passenger transport accounts for a full 42% of total energy consumption in Cape Town. Although this figure is put forward with some reservations,[40] it is clear that passenger transport dominates Cape Town's energy picture. This has enormous implications for Cape Town's urban and transport planning. When aviation and marine fuels are excluded, the picture is even starker.

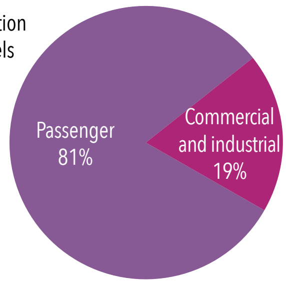
Figure 64: Energy consumption in the transport sector, Cape Town, 2012



Source: City of Cape Town, DoE, SAPIA, SEA.

Figure 65: Proportion of liquid fuel consumed by passenger vs commercial and industrial transport, Cape Town, 2012*

* excluding aviation and marine fuels



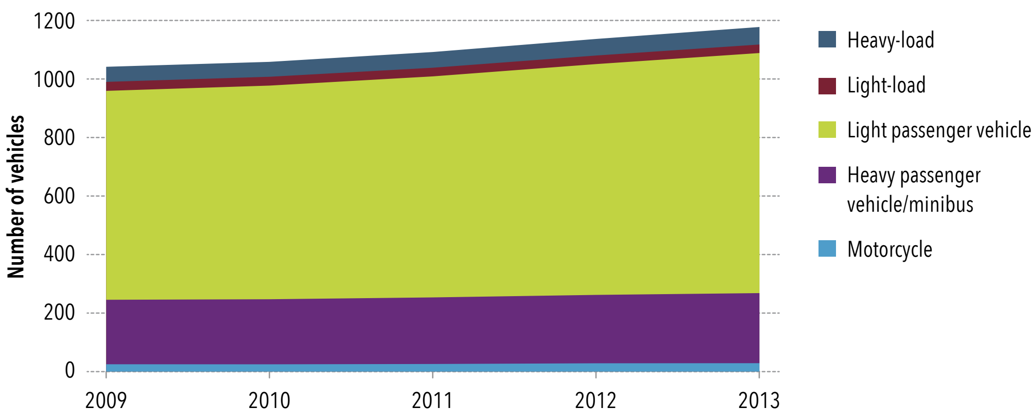
Source: City of Cape Town, DoE, SAPIA, SEA.

There is a strong link between vehicle population and energy demand. Ownership of light passenger vehicles increased by 15% from 2009 to 2013 and has doubled over the past 15 years.[41] These rates are far above population or economic growth. The growth in the number of vehicles on the existing road network causes increased congestion. This, in turn, pushes up fuel consumption as vehicles spend more and more time on the road. Assuming, conservatively, that approximately 75% of transport fuels in 2012 were for passenger transport, this represents a cost to the economy of some R12 billion (in 2002 real terms).

Table 34: Estimated cost of passenger transport in Cape Town (ZAR 2005 constant)

2012	Litres	Cost/ℓ (ZAR 2005 constant)	Total cost	Passenger transport estimate 75%
Petrol	1 433 710 154	R7,4	R10 580 780 937	R7 935 585 702
Diesel	917 373 532	R6,9	R6 320 703 635	R4 740 527 727
Total	–	–	R16 901 484 572	R12 676 113 429

Figure 66: Vehicle ownership by type, Cape Town, 2009–2013[42]



Sources: eNatis.

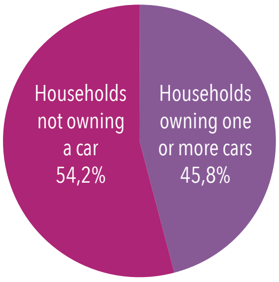
Ownership of light passenger vehicles increased by 15% from 2009 to 2013 and has doubled over the past 15 years. These rates are far above population or economic growth.

40. Obtaining a picture of the breakdown of petrol and diesel between sectors is no mean feat. SAPIA allocates sales to various sectors, but a large portion is simply 'general sales', a hold-all category of sales from fuel stations where no account is used. The vast majority of this, particularly with regard to petrol sales, will be for passenger transport, but some would be commercial and industry-related transport.
41. City of Cape Town Transport for Cape Town, statement made in workshop, 2014.
42. eNatis live vehicle population data, 2012.

6.3.3 TRANSPORT MODAL SPLIT

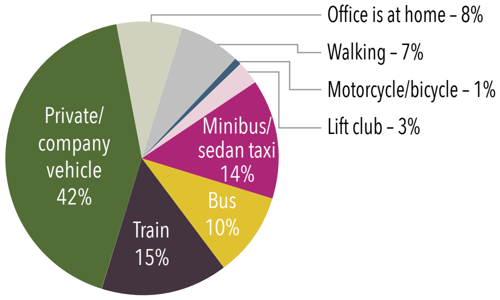
Despite the rapid increase in car ownership, the majority of households (54%) in Cape Town in 2011 did not own a car (thus, half of the city's households own two cars). These residents (37% of commuters) use public transport (train 15%, minibus taxi 14%, and bus 10%). Walking is a significant factor in mobility in Cape Town, and a large number of residents (7%) walk to work.

Figure 67: Car ownership, Cape Town, 2011



Source: Stats SA.

Figure 68: Mode of transport to work, Cape Town, 2012[43]



Source: Stats SA.

The overall modal split between private and public transport in Cape Town in 2012 was 54:46, while the split between motorised and non-motorised modes was 84:16.[44] Over time, there has been a 3% shift from public to private transport.

Table 35: Transport modal splits, Cape Town, 2009 and 2012

Travel mode	2009	2012
Motorised vs non-motorised		
Motorised	83%	83%
Non-motorised	15%	16%
Public vs private motorised		
Public	51%	46%
Private	49%	54%

Source: Stats SA General Household Survey 2009 and 2012.

The City is busy with an integrated rapid transit (IRT) programme. Measures within this programme include the priority rail plan, bus rapid transit (BRT), improvements to conventional bus and minibus operations, cycle ways and bicycle parking, pedestrian and urban space upgrades, metered-taxi integration and park-and-ride facilities.

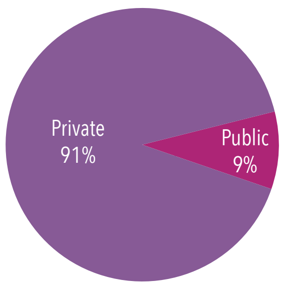
Despite the modal split between public and private transport being fairly equal in terms of total number of persons, the energy consumption split is very different: Public transport, including all minibus and bus operations as well as rail electricity consumption, consumes only 9% of total passenger transport energy.[45] Private passenger transport, on the other hand, is extremely energy-intensive.

6.3.4 PUBLIC TRANSPORT

Local government participates in the planning for public transport, but the operators for each mode implement services independently. All commuter rail services in Cape Town are provided by Cape Metrorail, a business unit of Transnet (falling under the ambit of the national Department of Transport). Bus subsidies and service contracts, other than for the MyCiTi bus (a City operation), are controlled by Province, which also regulates the minibus operators.

The City is busy with an integrated rapid transit (IRT) programme. Measures within this programme include the priority rail plan, bus rapid transit (BRT), improvements to conventional bus and minibus operations, cycle ways and bicycle parking, pedestrian and urban space upgrades, metered-taxi integration and park-and ride facilities. The objective is to make all these modes work as a seamless and integrated package of options for the travelling public.

Figure 69: Public vs private passenger transport energy consumption, Cape Town, 2012



Source: City of Cape Town, DoE, SAPIA, SEA.

BRT is a high-quality bus-based transit system that should deliver fast, comfortable and cost-effective urban mobility through the provision of segregated right-of-way infrastructure, rapid and frequent operations, and excellence in marketing and customer service.

43. Stats SA, *General Household Survey* 2012.
44. *Ibid*.
45. City of Cape Town, Energy Futures updated report, "Energy scenarios for Cape Town", 2015.

The overall time frame to implement the BRT rollout plan is likely to be between 15 and 20 years. The approach is a phased one, rolling out the system from the city centre up to Blouberg and Atlantis, and eventually covering the entire Cape Peninsula, complementing the city's rail services. There are four phases to the roll-out process. Currently, the City is busy with phase 1A.[46]

Rail accounts for the majority of public transport use in Cape Town, with minibus taxis and Golden Arrow bus operations also making a sizeable contribution.

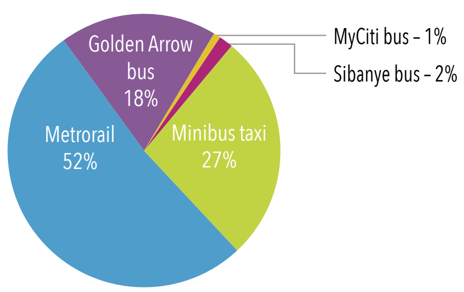
Table 36: Bus, minibus and rail operations in Cape Town, 2012[47]

City buses	MyCiTi operations	Golden Arrow bus operations	Sibanye operations	Minibus	Metrorail
Fleet size	81	1 056	78	7 600	–
Peak (buses)	60	971	72	7 600	–
Departures per day	1 015	5 198	262	30 800	–
Departures/week	6 805	29 337	1 521	175 000	–
Passengers/day	10 754	220 028	19 972	323 300	621 833
Passengers per annum	3 144 361	39 635 309	3 956 460	90 000 000	186 600 000
Kilometres travelled per annum	595 408	92 600 000	3 897 198	Unknown	–
Number of routes operated	7	2 269	155	565	–
Average trip length (km) – main route only	17	31	48	Unknown	–

6.3.5 COMMUTER TRIP LENGTH

Some 10% of commuters in Cape Town spend over an hour commuting to their place of work, while 35% spend 30 minutes to an hour travelling to work. Data indicate that the growth experienced in Cape Town is resulting in longer trip time overall (growth in trips over 60 minutes and decline in trips from 15 to 60 minutes). The data further reveal that those travelling by bus or train are worst off in terms of trip duration. In racial terms, black residents of Cape Town bear the greatest burden of lengthy travel times, which may be traced back to previous segregated urban development policies, but has persisted through housing development further and further away from job and other opportunities. This affects households' ability to care for children, their health and welfare.

Figure 70: Distribution of public transport operations by passengers per day, Cape Town, 2012[48]



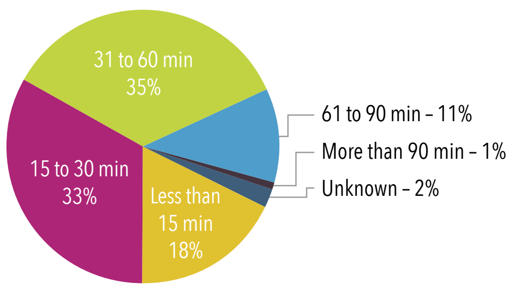
Source: Stats SA.

Data indicate that the growth experienced in Cape Town is resulting in longer trip time overall (growth in trips over 60 minutes and decline in trips from 15 to 60 minutes). The data further reveal that those travelling by bus or train are worst off in terms of trip duration.

Table 37: Commuter time taken to travel to work, Cape Town, 2009 and 2012[49]

Time taken to travel to work in Cape Town	2009	2012
Less than 15 min	15%	18%
15 to 30 min	36%	33%
31 to 60 min	37%	35%
61 to 90 min	6%	11%
More than 90 min	1%	1%
Unknown	4%	2%
Total	**100%**	**100%**

Figure 71: Travel time for commuters, Cape Town, 2012



Source: Stats SA.

Table 38: Average daily passenger trip distance per mode, Cape Town, 2010

Mode	Average trip (km)
Private car	17,5
Rail	22,8
Bus and minibus taxi	Unknown
MyCiTi BRT (main route)	16,7

Source: City of Cape Town Strategic Development Information and GIS Department; Transport for Cape Town, 2014.

46. www.capetown.gov.za.
47. City of Cape Town, Integrated Transport Plan, 2013-2018.
48. Stats SA, General Household Survey, 2012.
49. Stats SA, *General Household Survey*, 2012.

6.4. LOCAL GOVERNMENT

The City of Cape Town is assessed as a stand-alone sector. The City controls or has a direct impact on a host of functions and activities in the city. It is the single-largest user of energy in Cape Town, responsible for 1% of all energy consumption, 4% of all electricity consumption and 3% of global emissions. The City provides services to all citizens and is the single-largest employer.

Many of the City's functions have an energy implication, including bulk water supply and wastewater treatment, public lighting, public facilities, water and electricity services provision and waste management. Waste and wastewater management generates methane gas, which may be used to generate energy (while mitigating the very substantial GHG emissions of methane).

6.4.1 LOCAL-GOVERNMENT SECTOR ENERGY OVERVIEW

Electricity consumption accounts for the majority of energy consumption by the City of Cape Town as well as the majority of energy-related GHG emissions. However, on a sector basis, the vehicle fleet of the City is the single-highest energy consumer. Of course, this includes multiple service sectors (waste, electricity, etc.). Within the electricity-consuming sectors, the City's wastewater treatment plants and buildings together account for nearly half of all energy consumption. Street lighting, which has already undergone substantial efficiency retrofits, accounts for 17%. All city traffic lights have had the old tungsten bulbs replaced by enormously efficient light-emitting diodes (LEDs), which have reduced the electricity consumption of traffic lighting to very low levels.

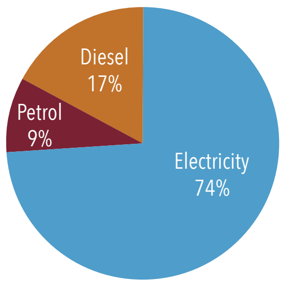
Energy to undertake its work and deliver services cost the City close on R2 billion in 2012.

Table 39: Estimated cost of local government energy consumption, 2012

City energy use	kWh/ℓ	Cost per unit (ZAR)	Total cost (ZAR)
Total kWh of City	356 249 565	0,42	R149 624 817
Total litres petrol	5 996 777	114,00	R683 632 578
Total litres diesel	9 999 489	106,00	R1 059 945 834
Total	–	–	R1 893 203 229

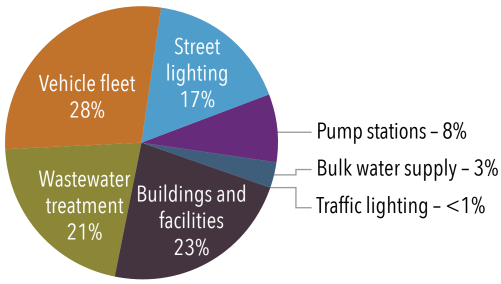
Note: Electricity rate based on average mega flex rate, as provided by NERSA 2010/11.
Source: SEA.

Figure 72: Local government energy consumption by energy source, 2012



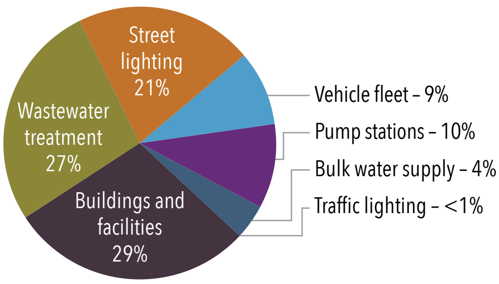
Source: City of Cape Town, Eskom.

Figure 73: Local government energy consumption by service sector, 2012



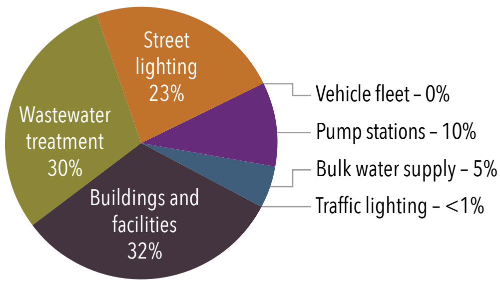
Source::City:of:Cape:Town:Electricity:Services:Department,:Eskom.

Figure 74: Local government GHG emissions by service sector, 2012



Source::City:of:Cape:Town:Electricity:Services:Department,:Eskom.

Figure 75: Local government electricity consumption by service sector, 2012



Source:: CtyfGaCpTeGon ECvecyrtctyf Gerstce: DeTprymeEy,C: kom.

Electricity consumption accounts for the majority of energy consumption by the City of Cape Town as well as the majority of energy-related GHG emissions. Energy to undertake its work and deliver services cost the City close on R2 billion in 2012.

6.4.2 DATA AND COMPARABILITY OF DATA OVER TIME

Data on local government energy consumption have improved considerably through data collection as part of the City of Cape Town's energy efficiency retrofit and monitoring programme. Better understanding of the internal metering systems needs to be gained in order to strengthen data-gathering over the years (in particular how SAP arrives at its total municipal electricity sales figure and the allocation of this to municipal consumption sectors).

Table 40: Local government energy and carbon emissions by service sector, 2012

Sub-sector	2012			Data source and method
Electricity (kWh)	**Native units**	**GJ**	**tCO_2e**	
Wastewater treatment works (WWTWs)	125 766 930	452 761	129 540	Actual consumption data from City of Cape Town metered by WWTW (including Eskom-delivered electricity of 49 029 357 kWh)
Buildings	135 114 966	486 414	139 168	Direct metering of approximately 80% of all City buildings (116 141 218 kWh), with remainder extrapolated from average consumption of that building type/sector
Bulk water supply	19 039 860	68 543	19 611	Estimations from kVA
Pump stations	44 426 340	159 935	45 759	Estimations from kVA
Street lighting: municipal	98 235 794	353 649	101 183	Calculations made from knowledge of actual stock, wattage and calculated at 11,3 hours/day. Cross-checked with Measurement and Verification figures.
Street lighting: Eskom	25 225 139	90 811	25 982	Eskom sales data
Traffic lighting	1 668 780	6 008	1 719	Calculations made from knowledge of actual stock and wattage, and drawing on Measurement and Verification figures.
Total electricity	**449 477 809**	**1 618 120**	**462 962**	This figure is slightly higher than the municipal sales figure (379 606 248), as it also includes electricity distributed directly from Eskom (to wastewater treatment plants) and Eskom-delivered street lighting. When these amounts are deducted, the total correlates fairly closely (375 223 313 kWh).
Vehicle fleet (ℓ)	**Native units**	**GJ**	**tCO_2e**	
Special Technical Services vehicle fleet: diesel	9 999 489	380 981	27 019	Collated from data held by municipal accounting systems, based on monthly records of payments to fuelling stations.
Special Technical Services vehicle fleet: petrol	5 996 777	205 090	13 655	As above
Total liquid fuel	**15 996 266**	**586 070**	**40 673**	
Total		**2 204 190**	**503 635**	

Data gathered by the City in a 'bottom-up' manner (i.e. instead of from electricity sales data) probably provide the most comprehensive picture of local government consumption to date. Previous *State of Energy* studies have only been able to include some sector-based data where figures were considered reasonably accurate, and then divided the remainder of the total between the remaining sectors (e.g. after traffic and street lighting had been allocated, the remainder was divided between buildings and wastewater treatment works). This makes comparisons over time tricky, particularly as previous data did not include Eskom sales, and data improvements may wrongly appear as consumption increases. The data below do not include Eskom street lighting; hence, figures are slightly lower than in the table above.

Table 41: Local government internal energy consumption, 2001–2012[50]

Sub-sector	2001		2007		2012	
	GJ	tCO_2e	GJ	tCO_2e	GJ	tCO_2e
Electricity						
Buildings and facilities	362 158	103 618	442 997	126 746	939 175	268 708
Wastewater treatment works	81 272	23 253	293 940	84 100	452 761	129 540
Buildings	279 771	80 046	149 057	42 647	486 414	139 168
Bulk water supply	0	0	149 057	42 647	68 543	19 611
Pump stations	0	0	0	0	159 935	45 759
Street lighting (municipal only)	372 242	106 502	330 307	94 505	353 649	101 183
Traffic lighting	9 720	2 781	36 399	10 414	6 008	1 719
Total electricity	744 120	212 901	958 762	274 312	1 527 310	436 980
Vehicle fleet						
Special Technical Services vehicle fleet: diesel	792 606	56 211	196 792	13 956	380 981	27 019
Special Technical Services vehicle fleet: petrol	282 402	18 802	267 587	17 816	205 090	13 655
Electricity Services Department diesel	0	0	43 358	3 075	0	0
Electricity Services Department petrol	0	0	24 450	1 628	0	0
Total liquid fuel	1 075 008	75 013	532 187	36 475	586 070	40 673
Total	**1 819 128**	**287 914**	**1 490 949**	**310 787**	**2 113 380**	**477 653**

50. Drawing on estimates from *State of Energy* studies for 2001 and 2007, and more accurate figures for 2012.

The City has been implementing energy-efficiency retrofit programmes within its Council operations since 2009.

Liquid fuel consumption in the first Cape Town *State of Energy* (2003) report seems to have been over-recorded. However, more work looking at all service sectors is required to confirm the liquid fuel consumption figures. Buildings and wastewater treatment electricity consumption appears to have increased – probably simply due to better levels of data-recording and collation. Street and traffic lighting electricity consumption decreased between 2007 and 2012 due to efficiency retrofits. Pump station consumption was estimated for the first time in 2012, drawing on kVA figures.

6.4.3 BUILDINGS AND MUNICIPAL OPERATIONS USING ELECTRICITY, AND EFFICIENCY PROJECTS

As noted, wastewater treatment, buildings and street lighting are the largest consumers of power. The City has begun to monitor consumption through the installation of smart meters in major buildings and the proper recording of consumption at all wastewater treatment facilities.

The City has been implementing energy efficiency retrofit programmes within its Council operations since 2009. This was kick-started by funding from the Danish International Development Agency (DANIDA) (building retrofits). In addition, the City is a participant in the Energy Efficiency Demand Side Management (EEDSM) programme, which is managed by DoE through the Division of Revenue Act (DORA) grant. As the City realises the savings potential of greater energy efficiency, it has also allocated its own funding and staff resources to the area of municipal energy efficiency management.

The focus of City energy efficiency interventions has primarily been on street lighting, traffic lighting and building energy efficiency retrofits. To date, the investment of grant and City funds has been R155 616 833, which generated a total saving of R102 566 987 from 2009/10 to 2014/15. The cumulative electricity savings and carbon emissions from 2009/10 to

Table 42: Summary overview of efficiency projects in local government operations, 2009–2014

Area	Action	Total actual savings for period 2009/10 to 2014/15	Typical payback period	Lead
Building efficiency	26% of all large City-owned buildings retrofitted since 2009 R69 million investment	R12,5 million 6 865 MWh 6 796 tCO_2e	9 years	ERMD working with Specialised Technical Services Department
Traffic lighting	100% retrofit with LEDs, and integrated with maintenance and procurement R29 million investment	R54 million 37 294 MWh 36 921 tCO_2e	3 years	Public Lighting Development
Street lighting	17% of street lights (all high-wattage luminaires) replaced with efficient alternatives; equal to 25 210 luminaires R57 million investment	R36 million 25 961 MWh 25 702 tCO_2e	8 years	ERMD with Transport for Cape Town and Electricity Services Department
Metering and monitoring	332 smart meters installed by the City	Accurate data collection to inform accurate billing of City buildings and inform efficiency strategy		ERMD
Rooftop PV to offset consumption	167 kWp (kilowatt-peak) installed on City buildings (rooftops), a further 90 kWp in the pipeline	Demonstration of leadership building of staff skills in relation to new technologies and approaches		ERMD, Electricity Services Department, Architecture, other

Source: City of Cape Town Environmental Resource Management Department.

2014/15 were 70 121 MWh and 69 420 tCO_2e respectively. These figures clearly prove that energy efficiency projects are of great benefit to the City and should be extended and supported.

A variety of departments have pioneered PV rooftop installations. These are relatively small installations and are electricity consumption offsets rather than generation projects. However, they provide the City with important opportunities to demonstrate leadership in terms of embedded, distributed energy.

Table 43: Local government installation of rooftop PV panels on own buildings and facilities, 2014

Installed to date	Size (kWp)	Grid-tied?	Commissioned
Manenberg housing contact centre	20	Yes	2012/13
Electricity Services Department building	100	Yes	2014
Gallows Hill	10	Yes	2015
Wallacedene taxi rank	20	No	2014
Khayelitsha environmental health centre	17	Yes	2014
Total	**167**		
To be installed	**Size (kWp)**	**Grid-tied?**	**Commissioned**
Royal Ascot (June 2015)	20	Yes	2015
Omniforum	60	Yes	2015
Civic Centre (after July 2015)	10	Yes	2015/16
Total	**90**		

Source: City of Cape Town Environmental Resource Management Department.

A variety of departments have pioneered PV rooftop installations. These are relatively small installations to date and are electricity consumption offsets rather than generation projects. However, they provide the City with important opportunities to demonstrate leadership in terms of embedded, distributed energy service development as well as to develop skills amongst municipal staff in relation to new forms of energy provision.

Five percent of the City's internal operations electricity demand is met through micro-hydro generation at its bulk water treatment plants. The potable water supply to the Cape Town metro area occurs principally through gravity mains. The kinetic and potential energy in the water mass is harnessed by passing the water through turbines, which generates electricity. The electricity generated through the micro-hydro plants is used at the bulk water treatments plants. This reduces the cost of potable water supply, and as micro-hydro is a renewable energy source of electricity generation it contributes to mitigating greenhouse gases during the generation process.

Table 44: Micro-hydro electricity generation by the City of Cape Town, 2012

Location	Type	Total turbine capacity (kW)	Total turbine production/annum (kWh)
Wemmershoek water treatment plant	2 x Francis	260	2 163 720
Blackheath water treatment plant	1 x Turgo	700	5 825 400
Faure water treatment plant	1 x Turgo	1 475	12 274 950
Steenbras water treatment plant	2 x Turgo	340	2 829 480
Total		**2 775**	**23 093 550**

** Plants are down for 5% per annum for maintenance.*

6.4.4 VEHICLE FLEET

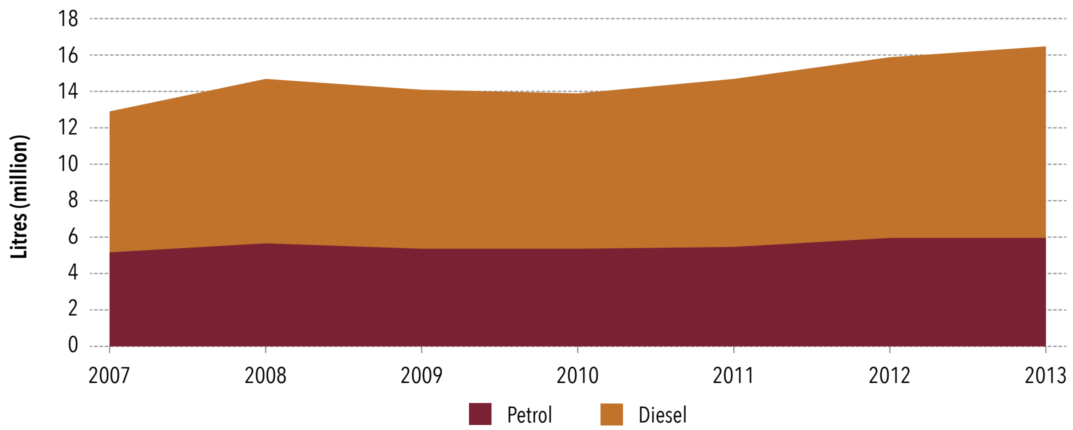
While the usual data qualifications apply here as ever,[51] the trends seem to indicate a sizeable increase in City diesel consumption from 2010, and climbing steeply beyond this. The drivers behind these trends are not well understood, and further work needs to be done to explore this. The City has moved to incorporate the operational cost of vehicles into the procurement process, and an evaluation of the impact of this on fuel consumption would be interesting. The figures also indicate that increases in fuel consumption lead to large increases in cost to the City and that the City is vulnerable to fuel price hikes.

Table 45: Local government vehicle fleet petrol and diesel consumption

Year	Petrol volume (ℓ)	Diesel volume (ℓ)	Total volume
2007	5 165 157	7 824 192	12 989 349
2008	5 564 413	9 077 253	14 641 666
2009	5 377 771	8 770 858	14 148 630
2010	5 419 653	8 646 602	14 066 255
2011	5 482 677	9 258 207	14 740 885
2012	5 996 777	9 999 489	15 996 267
2013	6 030 878	10 628 177	16 659 055
Source: City of Cape Town Environmental Resource Management Department.			
Year	**Petrol value (rand)**	**Diesel value (rand)**	**Total value**
2007	R33 831 169	R48 092 328	R81 923 498
2008	R49 145 647	R83 594 412	R132 740 059
2009	R38 745 900	R52 998 308	R96 074 784
2010	R43 452 260	R62 862 658	R104 855 728
2011	R55 024 110	R78 699 412	R131 444 112
2012	R67 246 819	R106 738 023	R173 984 843
2013	R75 621 507	R126 657 630	R202 279 136
Source: SEA (calculations based on City figures and using liquid fuel prices in constant ZAR 2005 terms, as published by DoE).			

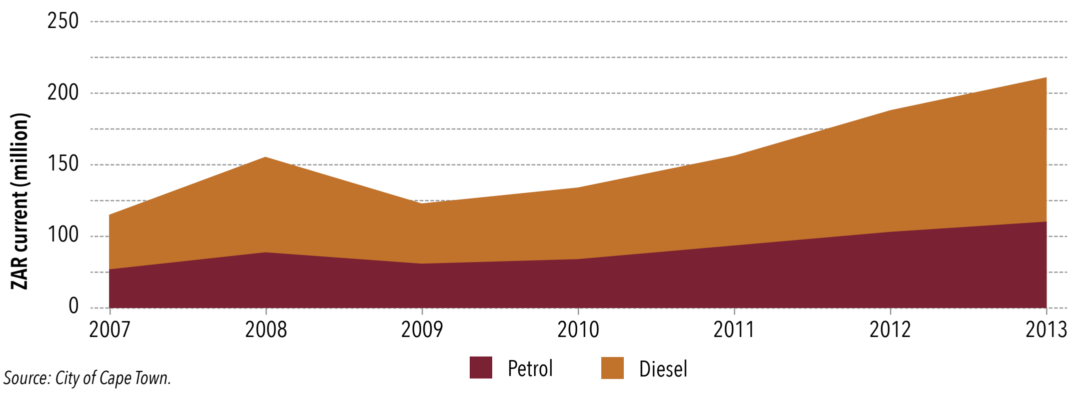
The trends seem to indicate a sizeable increase in City diesel consumption from 2010, and climbing steeply beyond this, but the drivers behind these trends are not well understood, and further work needs to be done to explore this.

Figure 76: Local government vehicle fleet petrol and diesel consumption, 2007–2013



Source: City of Cape Town.

Figure 77: Cost of local government vehicle fleet petrol and diesel consumption, 2007–2013



Source: City of Cape Town.

51. The *State of Energy* reports for the City recorded data in 2003 and 2009 – provided by the City at the time – which differ from the 2014 data provided by the City for the same years.

6.4.5 SOLID WASTE SECTOR

Transport is the largest component of energy consumption in the City's solid waste sector, which is captured within vehicle fleet/liquid fuel consumption analyses. An analysis of this sector is interesting, however, as it contributes to GHG emissions and may have waste-to-energy potential (mainly utilising methane gas). This report does not intend to go into these aspects in depth, but an overview of waste quantities over time is of interest.

Total waste generated by Cape Town has decreased over time over and above waste minimisation efforts, which are fairly sizeable (ranging from 6% to 13% over time). When looking at the waste composition, it is clear that this has resulted from diversion of garden greens out of the waste stream. From a sustainability perspective, the diversion of organic material from gardens back into the ecosystem through composting and chipping is a positive development.

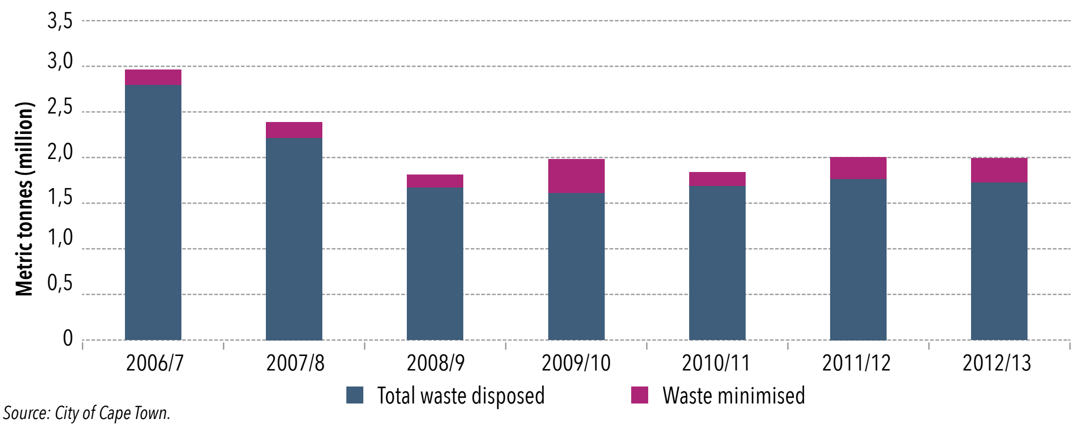
As a general rule of thumb for estimating biogas production from waste, experts believe 100 000 tonnes of domestic waste in a landfill per annum to be roughly equivalent to 1 MW. The actual gas yield is influenced by a variety of factors, including organic content and moisture in landfill. However, these 'ballpark' figures can be applied to sites to provide some idea of potential and to indicate whether further feasibility studies will be of value.

Table 46: Waste composition and quantities, with indicative waste-to-energy potentials, Cape Town, 2006–2012[52]

Waste types in tonnes	2006/7	2007/8	2008/9	2009/10	2010/11	2011/12	2012/13
General waste	1 361 718	1 277 179	1 162 311	1 141 884	1 281 844	1 302 074	1 282 658
Hazardous waste	58 342	110 098	66 203	57 882	52 219	41 625	32 326
Builders' rubble	0	0	0	0	286 366	336 363	314 427
Garden greens	1 370 180	826 999	439 219	409 981	65 499	85 340	94 600
Total waste disposed	2 790 240	2 214 276	1 667 733	1 609 747	1 685 927	1 765 402	1 724 011
Waste minimised	173 001	175 485	146 069	373 306	154 432	235 846	271 527
Total waste generated	2 963 241	2 389 761	1 813 802	1 983 053	1 840 358	2 001 248	1 995 537
Waste diverted	5,84%	7,34%	8,05%	18,82%	8,39%	11,78%	13,61%
Waste-to-energy indicative potential (MW)	27	21	16	16	13	14	14

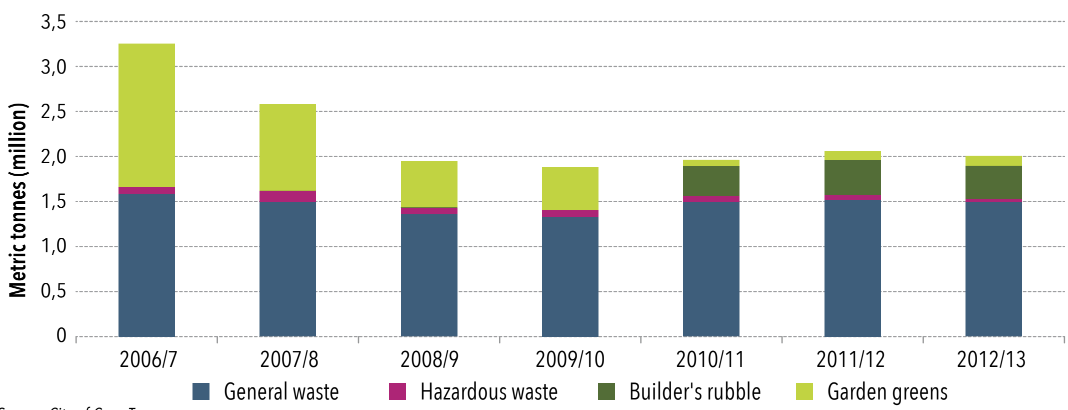
Source: City of Cape Town Solid Waste Management Department.

Figure 78: Waste volumes generated, Cape Town, 2006–2012



Source: City of Cape Town.

Figure 79: Waste composition, Cape Town, 2006–2012



Source: City of Cape Town.

Total waste generated by Cape Town has decreased over time over and above waste minimisation efforts, which are fairly sizeable (ranging from 6% to 13% over time). When looking at the waste composition, it is clear that this has resulted from diversion of garden greens out of the waste stream.

52. Waste minimisation figures reported in volume and converted to tonnes based on different ratios for different waste types.

7 CAPE TOWN **ENERGY SUPPLY**

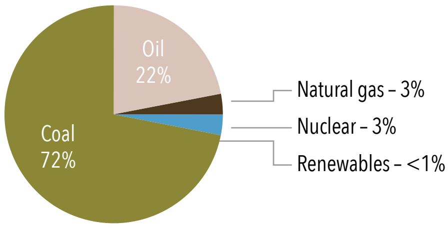
Coal continues to dominate South Africa's energy supply picture. This is mirrored in Cape Town. However, some important new areas of development with regard to more environmentally sustainable options are actively being explored.

7.1 SUPPLY OVERVIEW

Cape Town's energy supply continues to largely mirror the rest of the country. However, some important new areas of development and exploration include the private purchase of wind-generated power from an independent power producer (Darling Wind Farm) since 2009 and the acceptance of small-scale embedded generation from 2014. Given that power supply is a national function, the future of any net-generated, distributed alternative-supply developments is dependent on national policy directions.

The primary energy supply of South Africa continues to be dominated by coal: More than 70% of primary energy,[53] more than 90% of electricity and a third of liquid fuels are derived from coal. Due to this heavy reliance on coal, South Africa is the 15th-largest emitter of CO_2 from combustion of fuel sources, despite a far lower ranking in terms of its weight in the global economy (for example, the country's energy intensity – amount of energy per unit of economic output – is four times higher than the average for Organisation for Economic Cooperation and Development member states).[54]

Figure 80: Total primary energy consumption in South Africa, 2012



Source: BP Statistical Review of World Energy, 2013.

This chapter provides an overview of the energy supply picture for Cape Town. It looks at the policy and regulatory framework within which Cape Town operates with regard to meeting its energy needs, and then explores each energy source in terms of major developments, available resources, supply and distribution chains and any key issues relating to these.

Table 47: Energy sources (and related emissions) supplied to Cape Town as a proportion of national supply and provincial allocation, 2012

	City of Cape Town			% province	% national
Population	3 837 414			64%	7%
Economy (GDP)	276 044			73%	11%
Fuel	**Native unit**	**GJ**	**CO_2**		
Electricity total (kWh)	12 997 976 535	46 792 716	13 379 712	57%	6%
Coal (kg)	168 000 000	4 082 400	472 080	7%	1%
Petrol (ℓ)	1 433 710 154	49 032 887	3 264 558	83%	12%
Diesel (ℓ)	917 373 532	34 951 932	2 478 743	69%	8%
Paraffin (ℓ)	58 546 275	2 166 212	150 874	80%	11%
Liquid petroleum gas (ℓ)	91 201 615	2 435 083	147 929	50%	14%
Natural gas (ℓ)	0	0	0	0%	0%
Heavy furnace oil (ℓ)	39 276 949	1 633 921	116 574	34%	8%
Jet fuel (ℓ)	293 372 866	10 062 689	738 126	67%	12%
Aviation gas (ℓ)	895 897	30 371	1 975	42%	3%
International marine (ℓ)	196 767 565	7 496 844	531 666	No data	No data
Total		**158 685 055**	**21 282 238**	**54%**	**7%**

Source: Economy – Quantec; population – Stats SA; Electricity (national) – Stats SA Statistical Release P4141; non-electricity fuels (national) – DoE National Energy Balance 2009; fuels (provincial) – Western Cape Provincial Government Energy and Emissions Database (2009 data); liquid fuels (local) – DoE/SAPIA; coal (local) – communications with local distributors and Stats SA household energy figures; electricity (local) – City of Cape Town, Eskom.

In South Africa, more than 70% of primary energy, more than 90% of electricity and a third of liquid fuels are derived from coal.

Energy consumption in Cape Town across most energy sources and in total is proportionally slightly lower than its relative contribution to provincial and national population as well as economic production. A notable outlier is petrol, at 83% of provincial consumption. Petrol is usually associated with local passenger transport rather than freight (diesel), and the indication is that people in the city travel further each day and spend more time in traffic than people in smaller towns.

High paraffin consumption figures may be the result of this fuel being recorded in Cape Town before distribution throughout the province. Jet and marine fuels reflect the city's role as an international airport and harbour.

53. The DoE's *South African Energy Synopsis*, 2010, refers to 65,7% primary energy being coal. However, later figures from BP and the National Development Plan are quoted here. It is likely that the difference relates to definitions, with BP figures relating to renewable energy though not bio-waste figures (cow dung).
54. Government of South Africa, Department of the Presidency, *National Development Commission Diagnostic Report*, 2012.

Arnot power station in Mpumalanga (above) was Eskom's first modern coal-fired power station. It went into operation in June 1975, and nominally can generate 1 980 MW.

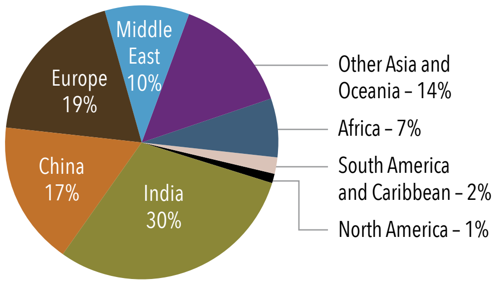
7.2 ENERGY SUPPLY SOURCES

7.2.1 COAL

South Africa produces in excess of 255 million tonnes of coal per year.[55] Coal provides for 72% of South Africa's primary energy needs. It is also the dominant primary fuel globally, where it accounts for about 36%-41% of total fuel consumption for electricity production. Altogether 28% of South Africa's coal is exported, making South Africa the fourth-largest coal-exporting country in the world. Coal is South Africa's third-largest export earner.

Coal production is concentrated in Mpumalanga, where over 80% of the country's total coal output is mined. The Witbank coalfield remains the largest producer of coal, followed by the Highveld coalfield, but is nearing depletion. The Waterberg coalfield has the potential to replace it. However, major rail infrastructure development is required to distribute this to the power plants, which were developed on the older coalfields.

Figure 81: South Africa's total coal exports by destination, 2012



Source: Global Trade Atlas (GTA); South African Revenue Service.

According to Department of Energy claims, at present rates of production, there should be more than 50 years of coal supply left. A 2010 analysis predicts a peak in production of about 284 Mt a year in 2020, at which stage approximately half (12 Gt) of the total resource (23 Gt) will have been exhausted.[56]

Coal production is dominated by five companies, which account for 85% of saleable coal production (of some 64 operating collieries).

The analysis asserts that the Waterberg coalfield (Ellisras basin) may be a remaining large resource, but structural complexity, finely inter-bedded coal-shale strata at large depths, low grades, high ash content and water scarcity are likely to inhibit its major development. Given South Africa's heavy dependence on coal for power generation and electricity supply, an anticipated peak production in 2020 will cause problems for future economic growth.

Coal production is dominated by five companies, which account for 85% of saleable coal production (of some 64 operating collieries). South African coal production feeds the various local industries in the following proportions:

- 65% for electricity generation
- 23% for petrochemical industries (Sasol)
- 8% for general industry
- 4% metallurgical industry (Mittal)
- 4% purchased by merchants and sold locally or exported

55. 2011 estimate in BP, *Global Energy Outlook*, 2012.
56. Hartnady, C, "South Africa's diminishing coal reserves", *South African Journal of Science*, 106(9-10), Pretoria, Sept/Oct 2010.

Chevron South Africa's Milnerton refinery in Cape Town (above) produces petrol, diesel, jet fuel, liquefied gas and other products. The refinery has a capacity of 110 000 barrels per day. Image courtesy of Chevron South Africa.

General industry distribution is dominated by a few large private companies, with a larger group of local distribution network-related companies. Household coal is supplied mainly by traders through informal yet established networks in townships. Given that the mining, distribution and sale of coal were deregulated in 1988, it is difficult to obtain distribution figures at the local level.[57]

Cape Town's relative distance from the coalfields and the lack of a heavy industrial base mean that coal supply into Cape Town is very limited. Coal is supplied into Cape Town by four main distributors. Coal is used in boilers, for heating within the clay and brick industries, and for laundry services in hospitals and prisons. Indications are that coal boilers are increasingly efficient, and with electricity price hikes and supply disruptions, more industry players may fuel-switch to coal.[58] Local coal burning will result in higher local emissions, which will affect air quality, but direct use of heat in heating applications results in higher energy efficiencies than electricity and lower global GHG emissions.

7.2.2 LIQUID FUELS AND NATURAL GAS

South Africa has small oil reserves and only modest gas reserves. At this stage, these are all off-shore fields. South Africa provides in about 5% of its fuel needs through gas, 35% through coal, while 50% is refined from crude oil (imported). The remainder is made up of imports, as demand for liquid fuel products in South Africa currently exceeds the country's ability to manufacture such products.[59]

From the 1950s, for political reasons, the South African government began a programme to reduce dependence on crude oil imports through the production of synthetic fuels from coal (Sasol) and gas (Mosgas, now PetroSA, and Sasol Gas). With the advent of democracy, the industry has become open, and state ownership has declined. The Petroleum, Oil and Gas Corporation of South Africa (PetroSA) manages the country's commercial assets in the petroleum industry, including the world's largest commercial gas-to-liquids plant at Mossel Bay in the Western Cape.

There is sizeable capital stock and management capacity to produce fuel from gas, but feed stocks have been declining. South Africa has now run out of refining capacity and must import a share of the country's refined fuel needs.

There is sizeable capital stock and management capacity to produce fuel from gas, but feed stocks have been declining. South Africa has now run out of refining capacity and must import a share of the country's refined fuel needs.

Debate is rife as to which strategy should be pursued to ensure the future security of South Africa's liquid fuel supply. State-owned company PetroSA is strongly advocating the development of a new crude oil refinery. However, other options exist, such as the development of a new coal-to-liquids refinery, the upgrade of existing refineries, or importing increased quantities of refined fuels (particularly possible with the development of large oil fields in Angola). Amid this debate, companies in the local liquid fuels sector are preparing for the roll-out of new fuel specifications in 2017, which will require refinery upgrades.

Imported and synthetically produced crude oil provides in about 22% of the country's primary energy needs. The vast majority of this crude oil comes from trading partners in Saudi Arabia, Iran and Nigeria. South Africa has four conventional oil

57. The method note within this report details how coal data may be obtained.
58. Personal communication with distributor, the Western Cape Health Department engineer, A Cunninghame, and technical director of a laundry business, 2014.
59. NPC Diagnostic Report, 2012.

While most of the transport fuel is produced in the coastal areas, about 68% of it is consumed inland in Gauteng. This requires investments in storage and distribution facilities for the supply of petroleum products at the point of need.

refineries – three on the coast (one in Cape Town, two in Durban) and one inland (Sasolburg). Crude oil is pumped in a pipeline from Durban to Sasolburg. The ratio of petrol to diesel production in South Africa's refineries and the demand for petrol and diesel do not match. This resulted in surplus diesel in relation to the demand in the past. However, the increasing number of diesel vehicles and the growing demand for liquid fuels have reduced this imbalance. The refineries produce more liquid petroleum gas than is consumed locally, and this is exported to the Southern African region.

While most of the transport fuel is produced in the coastal areas, about 68% of it is consumed inland in Gauteng. This requires investments in storage and distribution facilities for the supply of petroleum products at the point of need. Transnet Pipelines commissioned a multiproduct pipeline in January 2012, which will ensure that inland demand is met and will also cut congestion between Durban and Johannesburg by keeping tankers off the roads.

The Energy White Paper proposed minimum governmental intervention and regulation in the liquid fuel industry. In 2003, the basic fuel price (BFP) formula was introduced, which is essentially an import parity pricing formula. The formula makes use of comparative prices elsewhere as well as local handling costs. The BFP sets the price of fuel at the refinery gate. For petrol, the price is regulated to the retail level (price at the pump) and includes government tax and levies, a wholesale margin and service/zone differentials (inland vs coastal). The price of diesel is only controlled to the wholesale level. Paraffin is controlled to the formal retail level only. Liquid petroleum gas is also controlled from the refinery gate price and the retail prices.

The average real liquid fuel price increase between 2002 and 2014 was 5,5%.

Table 48: Retail prices of petrol and diesel, 2001–2014, in real terms, and year-on-year growth relative to growth in the consumer price index (CPI)

Year	c/ℓ (nominal)		CPI	c/ℓ (constant 2005)		c/ℓ (constant 2005)	
	Petrol	Diesel		Petrol	Diesel	Petrol	Diesel
2002	397,19	356,89	57,2	440,25	395,58		
2003	387,25	337,69	60,5	405,81	353,88	-7,8%	-10,5%
2004	437,33	383,55	61,4	451,58	396,05	11,3%	11,9%
2005	502,51	483,76	63,4	502,51	483,76	11,3%	22,1%
2006	600,19	571,47	66,4	573,07	545,65	14,0%	12,8%
2007	664,25	618,36	71,1	592,31	551,39	3,4%	1,1%
2008	885,71	925,00	79,3	708,12	739,53	19,6%	34,1%
2009	725,71	657,55	84,6	543,85	492,77	-23,2%	-33,4%
2010	811,83	731,76	88,2	583,56	526,00	7,3%	6,7%
2011	982,42	916,25	92,6	672,63	627,32	15,3%	19,3%
2012	1 138,64	1 063,20	97,8	738,14	689,23	9,7%	9,9%
2013	1 269,81	1 185,96	103,4	778,58	727,17	5,5%	5,5%
2014	1 388,00	1 292,89	109,7	802,18	747,21	3,0%	2,8%
Average annual increase						5,1%	5,4%

Source: Department of Energy.

7.2.3 ELECTRICITY [60]

Generation

Eskom generates 95% of the power in South Africa and operates 27 power stations with a nominal capacity of 41 919 MW, comprising 35 650 MW of coal-fired stations (91% of capacity), 1 860 MW of nuclear (4% capacity, but around 6,5% supply), 2 409 MW of gas-fired and 2 000 MW of hydro and pumped storage (with the latter largely being peaking stations).

In order to catalyse the 2003 Cabinet decision to allocate 70% generation capacity to Eskom and 30% to independent power producers (IPPs), with Eskom as the single buyer of power from IPPs (a later 2007 Cabinet decision), the Department of Energy has teamed up with the Public-Private Partnership Unit of National Treasury to facilitate the introduction of private renewable energy into the country's energy mix via a competitive bidding process. The Renewable-Energy Independent Power Producers Programme (REIPPP) is designed to contribute to the national renewable energy target of 10 000 GWh of renewable source electricity in the mix, which translates to an installed capacity (broadly in accordance with the Integrated Resources Plan 2010-2030) of 3 725 MW. To date, three bidding rounds have taken place. Projects in bidding round 1 have all reached commercial operation, delivering 1 182,62 MW of capacity. Projects from bidding round 2 have achieved 292,8 MW capacity, while bidding round 3 recently closed and adjudication is under way. A January 2015 REIPPP update issued by the Department of Energy announced that total megawatts actually connected to the grid to date are 1 915 MW. A further 1 512,72 MW have reached commercial operation.[61]

Current (2014) peak demand is just under 39 000 MW. This is likely to grow to about 60 000 MW by 2025.[62] A further 6 900 MW of old capacity will be retired, meaning that a total of approximately 28 000 MW additional demand will need to be met. The sector is currently characterised by an aging supply network and capacity reserve margins below the internationally accepted benchmark of 15%. In addition, the 2013 Coal Roadmap indicates the urgency of securing coal for Eskom power stations.

As of November 2014, the country has embarked on a process of controlled loadshedding. This is part of Eskom's programme to invest in upgrades and maintenance of the existing stock while waiting for the new-generation, coal-fired power stations Medupi and Kusile to come on line. These plants, both with a capacity of about 4 800 MW, are under development, but have been delayed. The associated major capital investments have required Eskom to apply for above-inflation tariff increases.

The electricity sector accounts for about half of the country's GHG emissions. In terms of international commitments, the country is under pressure to find alternatives to conventional coal-fired power stations to meet demand growth over the next 15 years. The practical alternatives to conventional coal as a primary energy source are imported hydropower, wind, solar, nuclear and 'clean' coal technologies – listed roughly in order of desirability from an environmental and resource-demand viewpoint.[63]

The electricity sector is currently characterised by an aging supply network and capacity reserve margins below the internationally accepted benchmark of 15%. In addition, the 2013 Coal Roadmap indicates the urgency of securing coal for Eskom power stations.

60. Much of this information is drawn from the Creamer Media Research Report, 2014.
61. Department of Energy, *Energy Programmes and Projects, Electricity Infrastructure/Industry Transformation*, presentation by Lebogang Mojanaga, 13 January 2015.
62. Government of South Africa, *National Planning Commission Diagnostic Report*, Department of the Presidency, 2012; Department of Energy, Integrated Resources Plan 2010-30, 2011.
63. Government of South Africa, *National Planning Commission Diagnostic Report*, Department of the Presidency, 2012.

Other technologies (such as natural gas from the Karoo, and wave power) are potentially important, but have not yet been shown to be viable. From a regional perspective, there is a substantial untapped hydropower potential on the Zambezi, on the Congo rivers as well as in Angola. While unlocking this capacity will be technically and politically challenging, it remains an important long-term option.

It remains unclear as to which direction the sector will take. On the one hand, government has stated its intention to embark on a big nuclear power programme and to support shale-gas explorations. On the other hand, the updated Integrated Resources Plan 2010-2030, with revised demand projections, shows that 6 600 MW less capacity than previously projected will be required by 2030. These new demand projections suggest that no nuclear base-load capacity is needed until at least 2025, and that alternative options, such as regional hydro, or shale-gas with embedded renewable energy, should be considered if the cost of nuclear power proves too high.

Sharp electricity price increases are required to finance investment in new capacity. Government has probably reached the limit of its support for Eskom in the form of R350 billion in guarantees and a further R20 billion equity injection, on top of a previous R60 billion subordinated loan. Eskom's access to private debt is becoming more difficult and expensive.

Sharp electricity price increases are required to finance investment in new capacity. Government has probably reached the limit of its support for Eskom in the form of R350 billion in guarantees and a further R20 billion equity injection, on top of a previous R60 billion subordinated loan. Eskom's access to private debt is becoming more difficult and expensive. Failure to raise electricity prices to levels that cover these costs will result in Eskom running at a loss, and maintenance and investment programmes being delayed, threatening electricity supply. It will be essential to complement price increases by measures to ensure affordable special tariffs for low-income families.

Municipal suppliers

Municipalities in South Africa own a total generation capacity of 2 432 MW. Altogether 1 932 MW of this is in coal stations, 320 MW in open-cycle gas-turbine stations, 4 MW in hydro-stations and 180 MW in pumped-storage stations. Most of the coal stations are old and have low load factors. Within Cape Town, the generation capacity is for load management and the City is not a net producer of electricity (see below).

Transmission and distribution

While a reliable electricity supply depends on having sufficient power available, it also requires reliable grid networks to transport the electricity to users. The Eskom-owned national electricity transmission grid covers over 2 000 km. Electricity is currently distributed by Eskom and municipalities. The intention was to restructure the distribution sector due to large differences between the performance and revenue of distributors – relating to previous, inequitable division of distribution areas. However, government's strategy of transferring all distribution networks to regional electricity distributors to address maintenance and investment shortfalls has failed. The uncertainty around restructuring of the electricity distribution industry has resulted in further underinvestment in physical and human capital by both municipalities and Eskom – to an amount estimated by EDI Holdings at more than R27 billion.[64] The National Development Plan points to the need for a funding plan to be developed to cater for this backlog, alongside a sustained support effort to encourage municipalities to ring-fence their electricity distribution businesses and operate them more sustainably.

Electricity planning and electrification

Electricity in Cape Town is provided by the City, as a distributor, and Eskom. The City distributes approximately three-quarters of total city consumption, with Eskom responsible for the remaining quarter.

Power sector and GHG reductions commitments

It is becoming clear that South Africa's Copenhagen offer for GHG emissions reductions will be hard to achieve. The country has probably already exceeded the 550 megatons per year CO_2 cap, and will certainly do so once Eskom's new coal power stations are commissioned. There is also a growing appreciation of how difficult it will be to reduce emissions in non-electricity sectors, which would require shifts from individual motor vehicles to public transport, massive improvements in energy efficiency, severely curtailing or transforming the production of synthetic fuels by Sasol, and changes in land use and forestry practices. There is no coherent policy framework to achieve such objectives.

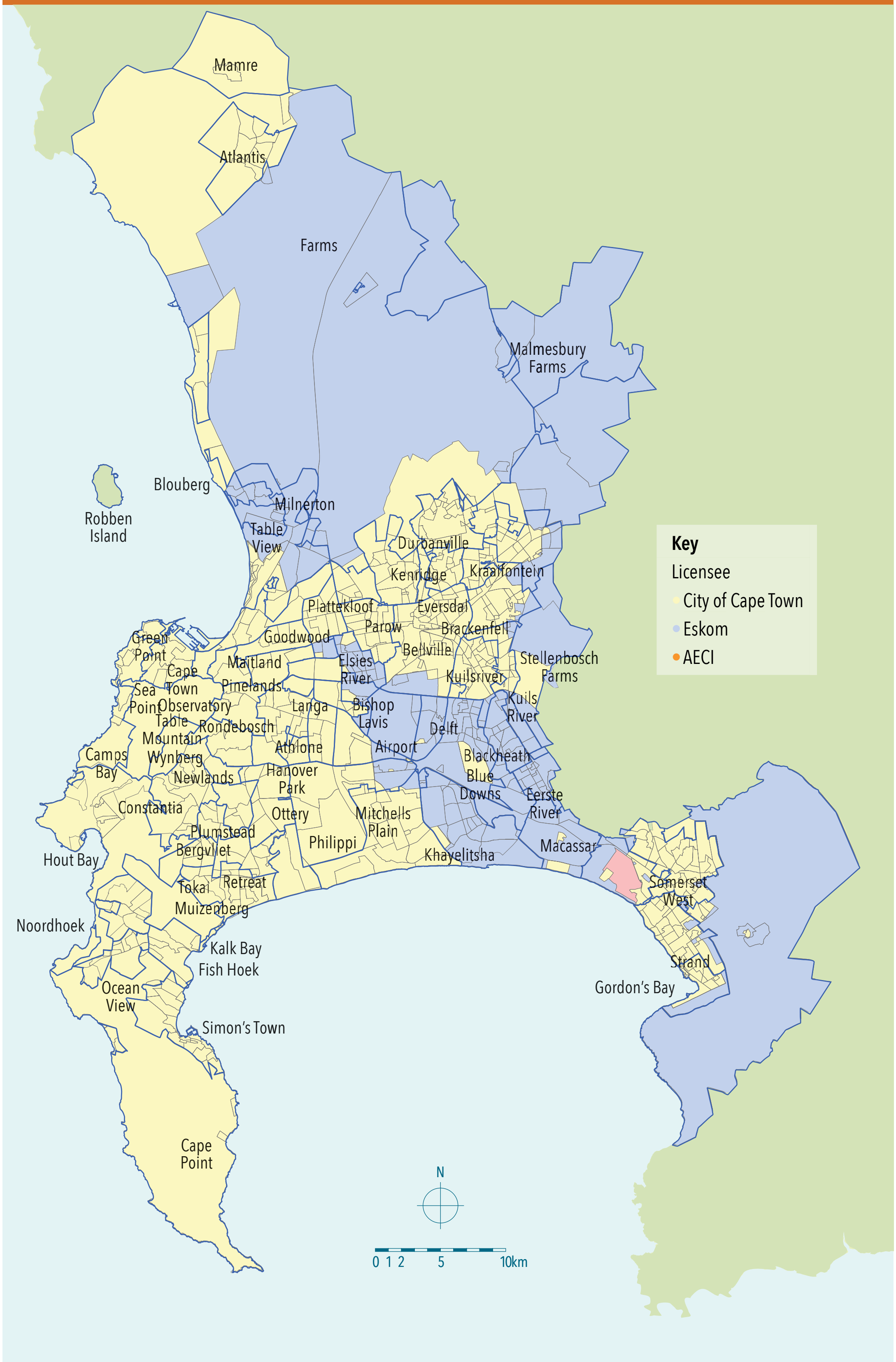
Recognising the difficulty of delivering emissions reductions in non-electricity sectors, some policymakers now argue that the power sector should increase its share of the burden in meeting the Copenhagen targets. However, the Integrated Resources Plan 2010 demonstrates that while significant reductions in CO_2 emissions can be obtained at relatively small incremental costs, costs start rising sharply if additional emissions reductions are forced onto the electricity sector. Cutting emissions from 275 to 220 megatons would imply a significant increase in costs as a result of relying more on base-load solar power. There is thus limited scope for arguing that the power sector should contribute significantly more than half the burden in emissions reductions. The value of the draft Integrated Resources Plan is to concentrate minds on the trade-offs.

Source: NPC Diagnostic Report, 2012.

64. Government of South Africa, *National Planning Commission Diagnostic Report*, Department of the Presidency, 2012.

The City of Cape Town's electricity distribution (i.e. excluding Eskom distribution) accounts for some 45% of provincial electricity distribution and 6% of national distribution.[65] In 2008, technical and non-technical losses accounted for 8% of the City's distribution. These losses grew to 11% in 2012 and 10% in 2013. By international benchmarks, 8% is fairly standard; certainly, by South African standards, 8–10% losses are fairly good. However, growth in this figure requires exploration: Does this relate to technical losses and aging infrastructure, or is it related to electricity theft?

Figure 82: City of Cape Town vs Eskom distribution areas (Eskom in blue)



Electricity in Cape Town is provided by the City, as a distributor, and by Eskom. The City distributes three-quarters of total city consumption, with Eskom responsible for the remaining quarter.

65. Stats SA, *Statistical Release P4141*, "Electricity generated and available for distribution (Preliminary)", July 2013.

Table 49: City of Cape Town electricity sales and losses, 2006-2013

Year	Bulk purchase	Total electricity sales	Losses	% losses
2006/7	10 299 114 341	9 385 198 791	913 915 550	8,87%
2007/8	10 598 771 335	9 757 991 762	840 779 573	7,93%
2008/9	10 660 268 388	9 719 524 344	940 744 044	8,82%
2009/10	10 563 268 399	9 721 837 716	841 430 683	7,97%
2010/11	10 554 633 564	9 588 675 082	965 958 482	9,15%
2011/12	10 423 926 028	9 176 081 697	1 247 844 331	11,97%
2012/13	10 273 481 213	9 232 701 286	1 040 779 927	10,13%

Source: SAP data, City of Cape Town Electricity Services Department.

Geographic spread of distribution

The City distributes electricity through five transmission areas. The geographic spread of this distribution (in quantity) is shown below.

Table 50: City of Cape Town electricity distribution by transmission area

Cape Town	Tygerberg	Blaauwberg	Oostenberg	Helderberg	Total
kWh	kWh	kWh	kWh	kWh	kWh
6 418 740 118	2 414 535 040	469 051 195	618 314 547	510 107 272	10 430 748 173

System maximum demand forecast

System demand in 2012 sat at just below 1 900 MW – where it had been since 2008, with some small ups and downs. This is far below what was forecast. By 2013, it had increased slightly to just above 1 900 MW.[66]

The anticipated disaggregated substation demand data will greatly enhance the City's understanding of demand drivers across the metro area as well as related energy distribution system and efficiency planning. Improved management of demand has huge potential in terms of managing electricity costs and revenues for the City.

The City of Cape Town has three power stations, which are used for load management: the Steenbras Dam pumped-storage facility, the Athlone gas turbine and the Roggebaai gas turbine. The City is not a net generator of electricity. Athlone and Roggebaai (40 MW capacity each) produce a very small amount of power and run during the winter peak.

Electricity generation by the City

The City of Cape Town has three power stations, which are used for load management: the Steenbras Dam pumped-storage (SPS) facility, the Athlone gas turbine (AGT) and the Roggebaai gas turbine (RGT). The City is not a net generator of electricity. Athlone and Roggebaai (40 MW capacity each) produce a very small amount of power and run during the winter peak. Steenbras (180 MW capacity) imports from Eskom during off-peak times to pump water uphill and then runs it down during peak to produce 'cheaper' power for the City (i.e. effectively at the lowest rate from Eskom). This is a fairly large operation, but consumes more power than it produces, with the plant achieving a 70% efficiency rate.

Table 51: Electricity generation by the City of Cape Town, 2012

2012	Steenbras (SPS)	Athlone (AGT)	Roggebaai (RGT)	Generation total	SPS import
	kWh	kWh	kWh	kWh	kWh
Jan	15 400 000	-11 730	-11 600	15 376 670	20 218 400
Feb	11 284 900	-10 160	-9 700	11 265 040	13 296 900
Mar	15 983 900	-10 240	-10 200	15 963 460	15 518 600
Apr	8 767 600	-9 650	-9 000	8 748 950	8 185 300
May	11 290 800	-5 640	210	11 285 370	15 351 400
Jun	10 673 200	256 750	76 930	11 006 880	15 172 300
Jul	12 148 800	-9 060	22 370	12 162 110	15 131 800
Aug	11 525 700	110 430	64 300	11 700 430	11 026 100
Sep	6 334 800	36 350	-3 540	6 367 610	7 627 400
Oct	7 397 300	79 390	-8 600	7 468 090	10 044 300
Nov	4 687 900	-9 020	-7 700	4 671 180	4 540 300
Dec	8 244 900	9 900	9 300	8 264 100	10 026 300
Total	123 739 800	427 320	112 770	124 279 890	146 139 100
Net generation				-21 859 210	

Source: City of Cape Town Electricity Services Department, 2014.

The City has recently installed photovoltaic (PV) panels on a number of its municipal buildings. To date, these amount to 257 kWp of capacity (see table 43 for details). These will support demand reduction. The City is also exploring other renewable energy generation opportunities, such as micro-hydro-schemes on the City's water pipe systems, sewage methane for electricity to reduce on-site electricity costs at wastewater treatment works, and landfill biogas for electricity.

66. According to documentation from City of Cape Town Electricity Services Department, Peter Jaeger, 2014.

Five percent of the City's internal operations electricity demand is met through micro-hydro generation at its bulk water treatment plants. The potable water supply to the Cape Town metro area occurs principally through gravity mains. The kinetic and potential energy in the water mass is harnessed by passing the water through turbines, which generates electricity. The electricity generated through the micro-hydro plants is used at the bulk water treatments plants. This reduces the cost of potable water supply, and as micro-hydro is a renewable energy source of electricity generation it contributes to mitigating greenhouse gases during the generation process.

Table 52: Micro-hydro electricity generation by the City of Cape Town

Location	Type	Total turbine capacity (kW)	Total turbine production/annum (kWh)
Wemmershoek water treatment plant	2 x Francis	260	2 163 720
Blackheath water treatment plant	1 x Turgo	700	5 825 400
Faure water treatment plant	1 x Turgo	1 475	12 274 950
Steenbras water treatment plant	2 x Turgo	340	2 829 480
Total		**2 775**	**23 093 550**

** Plants are down for 5% per annum for maintenance.*

Electrification and access to electricity

The electrification programme was started by Eskom in the late 1980s and was refined by the Reconstruction and Development Programme and the Energy White Paper of 1998. From 2001 onwards, government took responsibility for funding electrification via National Treasury. Electricity distributors are responsible for the roll-out of electrification within their distribution areas.

Household electrification was increased from 36% in 1994 to 87% (5,7 million households, mostly in urban centres) in 2012[67] – a significant milestone for South Africa and unprecedented internationally. However, the ambitions to achieve universal access by 2014 are unlikely to have been met, with insufficient funds having been committed and connection rates having slowed down. New targets set by the Department of Energy in February 2013 are to supply electricity to 97% of households by 2025 (previously 92% by 2014).

The City of Cape Town leads the country with levels of electrification, with 100% of formal housing electrified and 94% of total households electrified.

Across South Africa household electrification increased from 36% in 1994 to 87% (5,7 million households, mostly in urban centres) in 2012 – a significant milestone for South Africa and unprecedented internationally.

Table 53: Electrification status of formal and informal households in South Africa's metros, 2014

Metro	% households electrified	% formal households electrified	% informal households electrified
Cape Town	94%	100%	Not monitored
Ekurhuleni	82%	No data available	0%, but has provided 2 400 off-grid solar lighting kits to informal households
eThekwini	90%	70%	<1%
Johannesburg	91%	100%	100% of category 1* and category 2**; 0% of category 3*** households
Buffalo City	81%	Approximately 80%	Not monitored

** Category 1 denotes households in informal settlements earmarked for an upgrade.*
*** Category 2 denotes informal households earmarked for regularisation, but that will be relocated in the future.*
**** Category 3 denotes households in informal settlements located on unsuitable land and in need of relocation.*
Source: Stats SA 2011; personal communications with municipal officials, 2014, for Household Energy Poverty Report; SEA, 2014.

Free basic electricity has recently moved away from being based on consumption to being allocated to customers on the Lifeline tariff. Qualification for the Lifeline tariff is determined by the consumption level, property value and meter type. This provides an allocation of 60 kWh for free for those consumers using less than 250 kWh, and 25 kWh for those consumers using between 250 and 450 kWh. The City has also embarked on a programme of installing separate meters in some backyard dwellings so that multiple households on a single plot are not discriminated against in terms of accessing the grant.

67. Department of Energy, Integrated Energy Report, 2012.

Electricity sales and prices

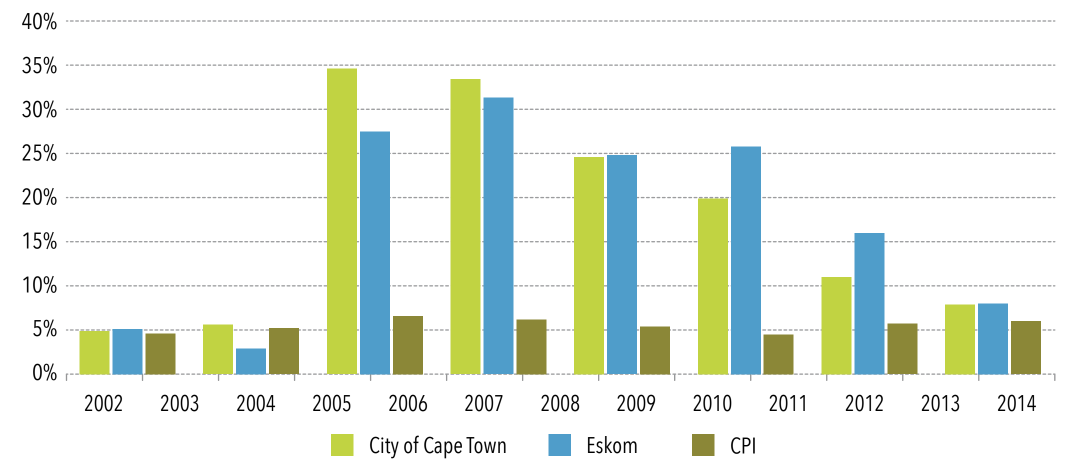
Electricity is sold by Eskom to redistributors, who in turn sell to residential, commercial and industrial customers. As a matter of policy and encouraged by government, Eskom has tried to keep the price of electricity below inflation. However, with the need for large capital investments to meet growing demand, this has not been possible. The City's electricity tariffs since 2008 have been above consumer price index (CPI), sometimes as much as three times higher. Eskom distribution tariffs (not represented here) would be very similar.

Table 54: Average increases in City of Cape Town electricity prices, relative to increases in consumer price index[68]

	City	Eskom	CPI*	CPI
Year	%	%	%	%
2006/7	4,9	5,1	4,6	0,047
2007/8	5,6	5,9	5,2	0,071
2008/9	34,6	27,5	6,6	0,115
2009/10	33,4	31,3	6,16	0,071
2010/11	24,6	24,8	5,4	0,043
2011/12	19,9	25,8	4,5	0,05
2012/13	11	16	5,7	0,056
2013/14	7,9	8	6	0,057

** CPI as published in Eskom tariff history document.*

Figure 83: City of Cape Town, Eskom tariff increases over time compared to CPI, 2002–2014



Source::City:of:Cape:Town:Electricity:Services:Department,:Eskom.

To address the fact that poor households are spending a far higher proportion of their household income on electricity, NERSA introduced the inclining block tariff (IBT) in 2010 to help cushion low-income electrified households from particularly sharp electricity price increases.

To address the fact that poor households are spending a far higher proportion of their household income on electricity,[69] NERSA introduced the inclining block tariff (IBT) in 2010 to help cushion low-income electrified households from particularly sharp electricity price increases. The system introduces higher per-unit charges as the rate of consumption increases. A major finding of the study is that, where it has been applied (only 30% of municipalities), the IBT system has failed to insulate the poor from increases in electricity tariffs: The impact on bills compared to the flat-rate tariffs applied previously is marginal.[70]

7.2.4 DEMAND-SIDE MEASURES AND ENERGY EFFICIENCY INTERVENTIONS

In terms of both the Integrated Energy Plan's 'policy-adjusted' scenario (taking into consideration the Copenhagen Accord emissions reduction commitments) and the updated Integrated Resources Plan 2010, which speaks to the short-term capacity constraints, the need for aggressive demand-side interventions in the sector is emphasised. This speaks substantially to the local government sector, yet no plan to provide systematic, target-oriented support for this has been developed beyond a small reference in the 2013 National Energy Efficiency Plan. However, some important strides have been made in the building regulatory environment and with a national municipal Energy Efficiency and Demand Side Management (EEDSM) programme, which has catalysed efficiency retrofit activities within municipalities.

The National Building Regulations, Part XA, "Energy efficiency", came into effect during 2012/13. This involved the amendment of the National Building Regulations to include energy-efficiency standards in all residential and commercial buildings. Importantly, these standards include water heating, where at least 50% of heating needs must be achieved by non-electrical

68. City of Cape Town Electricity Services Department, 2014.
69. Palmer Development Group, *Review of the impact of inclining block tariffs for electricity on poor households*, 2013.
70. *Ibid*.

The City of Cape Town's Electricity Services Department's headquarters in Bloemhof, Bellville (above), is the second local government building in South Africa to achieve a four-star rating from the Green Building Council SA (GBCSA) – the first was the City's Manenberg client contact centre.

resistance means. The amendment makes provision for building envelope, fenestration, passive solar heating and insulation. The City of Cape Town has successfully adapted building approval processes to include these new requirements.

The DORA-funded EEDSM programme was established in 2009 and has been running since then. This programme, run by the national Department of Energy, provides municipalities with funding on the basis of a business plan submission and selection process to undertake retrofits of public lighting and facilities. The City of Cape Town has been a beneficiary of the programme since its inception and has used the funding to successfully complete retrofits of its traffic and street lights as well as its buildings.

To date, the investment of DORA EEDSM grant funding has totalled R80 million. Investments have included traffic and street-lighting retrofits, building retrofits (lighting and HVAC) and building and operations meter installations. Efficient pumps for water and wastewater pumping are now being explored. To date, interventions have generated annual savings of R25 million. This results in a payback period of seven years and clearly indicates that energy efficiency projects are worth pursuing.

The Department of Energy has also been running a national solar water heater (SWH) roll-out programme towards the minister's target of one million SWHs by 2015. Institutional complexity between the Department and Eskom (as the programme implementers) has resulted in some delays in this programme.

Eskom has also been running a private-sector EEDSM programme with a range of funding lines, such as the standard offer, etc., as well as a national SWH subsidy since 2008 through an allocation within the multi-year price determination. The programme had begun to achieve inroads, but in November 2013, Eskom placed a temporary hold on its energy efficiency rebate programmes[71] in light of financial constraints. The most recent multi-year price determination, where Eskom requested a price increase of 16%, but was allocated only 8% annual increases, has meant that Eskom's EEDSM programme is currently not being funded.

7.2.5 RENEWABLE AND SUSTAINABLE ELECTRICITY AND ENERGY

As noted earlier, the REIPPP has been successful in bringing renewable electricity supply on line in very short timeframes. An interesting new development is the advent of embedded generation, i.e. generation within local distribution networks.

The National Development Plan notes: "Worldwide, there is a general trend towards decentralisation of energy supplies. This trend runs counter to the historical practice in the domestic electricity sector, where economies-of-scale arguments have dominated. The marginal efficiency advantages of mega-facilities need to be balanced against the inefficiencies of transmission losses, and the vulnerability and inflexibility of centralised systems. The advent of 'smart grids' overcomes many of the disadvantages of highly disaggregated systems, even to the point where individual households can be treated as energy generators."

Up to now, the Integrated Resources Plan (IRP) of 2010, which serves as the national electricity plan, has given no consideration to small-scale embedded generation (SSEG) systems. However, the recent proposed revisions to the IRP explicitly include consideration of SSEGs, partly due to the fact that capital for such systems comes entirely from private sources, unlike

The REIPPP has been successful in bringing renewable electricity supply on line in very short timeframes. An interesting new development is the advent of embedded generation, i.e. generation within local distribution networks.

71. Substantial amounts of the allocation went towards a 'buy-back' scheme during extreme capacity shortages.

Eskom generation installations. The roll-out scenario included in the IRP is significant – 10 000 MW by 2020. The plan recommends that such SSEG power be purchased by a central buyer to "render the municipalities indifferent between their Eskom supply and embedded generators and thus support small-scale distributed generation".[72] This provision, as well as the NERSA exemption from licensing requirements for those generating less than 100 kW, is likely to provide a favourable regulatory environment for SSEGs. However, it must be noted that this update has not been approved by Cabinet, and the development of the NETFIT[73] approach has also not been finalised or approved.

For municipalities that are also distribution utilities, this presents both opportunities and challenges. Opportunities identified are local economic development and grid enhancement. Challenges exist in terms of revenue, administration and technical grid management. Municipalities also have little choice: Either they create the administrative framework for this, or it will happen without regulation, creating potential hazards.

The embedded generation rollout scenario in the Integrated Resources Plan and the examption from licensing requirements for less than 100 kW will provide a favourable regulatory environment.

The 2011 NERSA standard conditions for SSEGs within municipal boundaries are referred to as "guidelines" within the document and are thus of uncertain regulatory status. They only deal with systems generating less than 100 kW and indicate that such systems do not require generation licenses from NERSA. The conditions require the municipalities to maintain a database of all small-scale (<100 kW) embedded generation installations within their area and to report to the Regulator on an annual basis on aspects such as number and capacity of installations, tariffs and safety. They are also required to ensure that the NRS 097-2-1:2010 grid interconnection of embedded generation is complied with.

Although this NERSA document is considered unclear and unrealistic by municipalities in several important areas, the most significant implication of the document is that SSEG systems below 100 kW do not require licences from NERSA. The Regulator has thus acknowledged that the trend to install SSEGs is accelerating and has effectively given municipalities authority to accept such systems without NERSA approval. By default, systems generating more than 100 kW do require NERSA licensing.

Most of the technical requirements for SSEGs are covered in the NRS 097 series of standards dealing with small-scale embedded generation:

- **NRS 097-2-1: utility interface** (approved and published, but new draft being developed)
  Focuses on the interface between the embedded generator and the utility. Device-independent. Mainly applicable to grid-connected systems interfaced through static power-converter technology. Specifies protection and safety requirements and metering arrangements, amongst others.
- **NRS 097-2-2: type testing** (out for comment)
  Deals with product type approval, installation requirements and certificates of compliance on the SSEG customer's side.
- **NRS 097-2-3: simplified utility connection criteria for low-voltage connected generators** (draft out for comment)
  Deals specifically with the commonly designed unidirectional flow of energy in low-voltage networks, with cumulative impacts of embedded generation. Provides basic acceptance criteria based on network strength and SSEG size, with substation configuration and metering arrangements.
- **NRS 097-2-4: procedures for implementation and application** (not started)
  This standard is yet to be developed.

72. Department of Energy, *Updated Integrated Resources Plan 2010-2030*, 2013, p 52.
73. A proposed national feed-in tariff for SSEGs.

In September 2014, the City of Cape Town finalised its application procedures and tariff structures for grid-tied SSEG implementation, and Black River Parkway became the first official, grid-tied PV system in Cape Town with a capacity of 1,2 MW. It is anticipated that other commercial installations will follow suit. A study undertaken in early 2014 (see appendices) indicated that current commercial PV rooftop installations stand at around 3 000 kWp. Although a number of households have installed PV panels, these installations are fairly insignificant by comparison, at around 150 kWp.

7.2.6 IMPACT OF RENEWABLE ENERGY AND ENERGY EFFICIENCY ON CITY OF CAPE TOWN REVENUE

A study undertaken by Sustainable Energy Africa (funded by the Renewable Energy and Energy Efficiency Partnership) examined the potential impact of energy efficiency and renewable energy on electricity business revenue. It found that PV rooftop installations are most viable for the commercial sector. While it is financially viable under current conditions, viability is greatly enhanced in ten years' time, at which point it will make sense not only for the commercial sector, but industry and households too.[74]

The following table provides the projected uptake of energy efficiency and renewable energy interventions in ten years' time in Cape Town. These estimates are based on economic viability and are linked to the Rogers technology uptake curve. Economic viability takes future costs and electricity tariffs into account. This will have a 4-11% impact on municipal electricity revenues. These figures do not take account of behaviour change.

A study found that PV rooftop installations are most viable for the commercial sector. While it is financially viable under current conditions, viability is greatly enhanced in ten years' time, at which point it will make sense for industry and households too.

Table 55: Projected uptake of energy efficiency and renewable energy interventions in ten years' time in Cape Town

		Year 10			
	Customers	Uptake range		Projected uptake	
Residential photovoltaic (PV)	182 318	15%	50%	27 348	91 159
Small commercial photovoltaic	19 433	15%	50%	2 915	9 717
Large commercial photovoltaic	600	50%	85%	300	510
Industrial photovoltaic	1 526	3%	15%	38	229
Residential solar water heater (SWH)	182 318	50%	85%	91 159	154 970
Residential energy efficiency (EE)	182 318	50%	85%	91 159	154 970
Small commercial energy efficiency	19 433	50%	85%	9 717	16 518
Large commercial energy efficiency	400	50%	85%	200	340
Industrial energy efficiency	13	50%	85%	7	11

7.2.7 WOOD

Wood as a source of energy in South Africa is used for both industrial and domestic purposes. In pulp mills, 'waste' by-product is collected and burned for process heat and electricity generation. In the residential sector, harvested wood is an important household fuel (for cooking as well as both water and space heating), particularly in rural, un-electrified households. The exact amount of wood fuel used is unknown, but is estimated at 86 petajoules (PJ) or 7 Mt of wood per year nationally.[75]

74. Sustainable Energy Africa, *Impact of localised energy efficiency and renewable energy on municipal finances over ten years*, 2014.
75. Department of Energy, *South African Energy Synopsis*, 2010; based on 2006 data.

8 REFERENCES

BP, *Global Energy Outlook*, 2012.

Creamer Media Research, *Electricity 2014: A review of South Africa's electricity sector*, 2014.

City of Cape Town, *Integrated Transport Plan 2013–2018*, 2013.

City of Cape Town, *Spatial Development Framework*, 2012.

City of Cape Town, *State of Energy*, 2003.

City of Cape Town, *State of Energy*, 2007.

City of Cape Town, Strategic Development Information and GIS Department, *Residents' commute to work and educational institutions in Cape Town, 2009 – 2011,* February 2013.

Dodd, Nick, *Community energy: Urban planning for a low carbon future*, URBED for TCPA, 2008.

Department of Energy, *Disaggregated national energy balance* spreadsheets, accessed from http://www.energy.gov.za/files/energyStats_frame.html.

Department of Energy, *Draft 2012 Integrated Energy Report*, 2012.

Department of Energy, *A survey of energy-related behaviour and perceptions in South Africa: The residential sector*, 2012.

Department of Energy, *Integrated Resources Plan (IRP) 2010–2030*, 2011.

Department of Energy, *Updated Integrated Resources Plan (IRP) 2010-2030*, November 2013.

Department of Energy, *South African Energy Synopsis 2010*, prepared by Mr Eyetwa Moses Maleka, Ms Lindiwe Mashimye & Dr Philip Goyns, 2013.

Economist Intelligence Unit, *Green City Index*, sponsored by Siemens, 2012.

Eberhard, A, *The folly of big coal, big nuclear and big networks*, seminar presentation, Energy Research Centre/Graduate School of Business, University of Cape Town, 4 September 2013.

eNatis Live Vehicle Population data, 2012

Government of South Africa, *National Development Plan: Vision for 2030*, 2013.

Government of South Africa, *National Planning Commission Diagnostic Report*, Department of the Presidency, 2012.

Hartnady, C, "South Africa's diminishing coal reserves", *South African Journal of Science*, 106(9–10), Pretoria, September/October 2010.

Hoekman, Paul, unpublished thesis, University of Cape Town, with original data source the Growth and Intelligence Network (GAIN) associated with Stellenbosch University.

Hoekman, Paul, *Urban-scale material flow analysis in the South African context: A Cape Town feasibility study* (unpublished thesis, University of Cape Town, 2015).

ICLEI, C40, World Resources Institute, *Global protocol for community-scale greenhouse gas emissions inventories (GPC) Draft Version 2.0*, July 2013.

ICLEI, *Cities for Climate Protection*, 2003.

Mthenthe Research Consultants, *Household energy user survey in selected areas in Cape Town, draft report*, for Sustainable Energy Africa, September 2014.

Palmer Development Group (PDG), *Review of the impact of inclining block tariffs for electricity on poor households*. Report for BUSA, Cape Town, 2013, available at http://www.ameu.co.za/ejournal/2013/9/30/inclining-block-tariffs-ibt-review-of-the-impact-of-inclinin.html [accessed November 2013].

South African Cities Network (SACN), *Consolidation of lessons learnt for energy efficiency and renewable energy initiatives within cities, development of a roadmap for future uptake*, prepared by Aurecon, November 2013.

South African Local Government Association (SALGA), *Local government energy efficiency and renewable energy strategy: status quo report*, prepared by Sustainable Energy Africa, 2014.

Statistics South Africa, *General Household Survey*, 2009–2012.

Statistics South Africa, *National Census*, 2001 and 2011.

Statistics South Africa, *Statistical release, P0441: Gross domestic product, annual estimates 2002 – 2011, regional estimates 2002–2011*, third quarter 2012.

Statistics South Africa, *Statistical release P4141: Electricity generated and available for distribution (preliminary)*, April 2014.

Sustainable Energy Africa, *Energy Futures (LEAP) model for Cape Town: Draft technical report*, Sustainable Energy Africa NPC, 2015

Sustainable Energy Africa, Cape Town Partnership, City of Cape Town, *The low-carbon central city strategy*, 2014.

Sustainable Energy Africa, *Impact of localised energy efficiency and renewable energy on municipal finances over ten years*, 2014.

Sustainable Energy Africa, *State of energy in South African cities 2015*. Sustainable Energy Africa NPC, 2015.

Sustainable Energy Africa, *Tackling urban energy poverty*, 2014.

UN-Habitat, *Global urban observatory*, 2008.

United Nations Statistics Division, *Global energy statistical yearbook*, 2014.

Visagie, HJ, *Pre-feasibility report for the importation of natural gas into the Western Cape with specific focus on the Saldanha Bay-Cape Town corridor,* for Department of Economic Development and Tourism, Western Cape Government, March 2013.

Western Cape Provincial Government, *Energy and carbon emissions database*, prepared by Sustainable Energy Africa, 2012.

World Bank, *Representative GHG baselines for cities and their respective countries*, 2011.

9 APPENDICES

9.1 METHOD NOTES

Demographic and economic data

Demographic data have been drawn from Stats SA's Census 2001 and 2011 data as well as the General Household Survey for 2001 (2011 household survey data still outstanding). All economic data come from Quantec datasets, which the City itself uses for all its economic analyses. These figures do differ slightly from national statistical publications on the economy, but differences are not considered significant.

National, provincial and City energy data for comparison over time

A comparison of energy consumption over time poses an enormous challenge. Data across spheres may not line up: For example, national energy data have a base year of 2009 and nothing for 2012, making proportional assessments difficult. Data collected for Cape Town in 2003 were also the first ever local-level energy data. Since then, data availability has changed – in some instances, it has improved; in others, it may have also deteriorated. Current data now often include back-data to the previous *State of Energy* years, with different quantities than those recorded in this report: Which quantity to work with? This is particularly apparent within local government, where an exceptionally fine level of detail is now gathered. For example, it is now apparent that some municipal consumption is supplied directly by Eskom, whereas previously, all data on municipal electricity consumption were gathered from municipal electricity accounts. This bumps up the figure, making it appear as if consumption has increased, while in fact, it is just a case of better data.

The following sources have been used for analysis of energy over time:

- City: Cape Town *State of Energy* report 2003 and 2007
- Province: Western Cape Department of Environmental Affairs and Development Planning, *Database of Energy consumption and energy-related emissions inventory for the Western Cape Province* (2012)
- National: Department of Energy *National energy balance 2010*

City energy supply-side

Electricity

Data on Eskom-supplied electricity (directly and to the City as redistributor) are derived from the City's bulk purchase figures, maintained by the Electricity Services Department, and Eskom's total sales within the municipal boundaries, maintained by Eskom itself. Eskom requires their data to be handled with extreme confidentiality, which can inhibit data-handling and storage.

Data on the City's maximum demand (relating only to the municipal redistribution component of electricity) are derived from its Electricity Services Department.

Independent power producer supply into the city relates only to a single producer and the power purchase agreement between the City and Darling Wind Farm. The total electricity purchased by the City is also provided by the Electricity Services Department.

The City had not approved small-scale embedded generation (at the time when data for this report were being gathered). Data were therefore derived from a 'cold-calling' survey of likely PV installers. Once the City has a fully approved process, the data should be readily available from the records of the Electricity Services Department.

Liquid fuel

Liquid fuel figures are obtained from the South African Petroleum Industry Association (SAPIA) via the Department of Energy (DoE). For a while, these figures were hard to obtain due to a Competitions Commission ruling on possible collusion. However, the commission has responded positively to requests to revisit the ruling, and these figures can now be obtained via the national DoE.

These figures include sales of all fuel types within the magisterial districts, and some degree of estimation is done in order to calculate proportions that relate to the Cape Town municipal boundaries. These estimates have been set up in a methodology (for the whole country) and can be obtained from Sustainable Energy Africa.

Two of Eskom's open-cycle gas turbines (OCGTs) for peaking power production, Ankerlig and Acacia, are located within Cape Town's boundaries. These power stations respectively run on diesel and jet kerosene. In order to avoid double-counting, the quantity of diesel/kerosene has to be established and deducted from the SAPIA diesel totals. Eskom recently published these figures,[76] allowing for a greater degree of accuracy than in previous years.

76. Detailed spreadsheet can be found on http://www.eskom.co.za/OurCompany/SustainableDevelopment/ Pages/CDM_Calculations.aspx.

In general, the SAPIA/DoE liquid fuel data appear to contain some inaccuracies and can in some instances swing fairly wildly from year to year. In terms of international marine, the SAPIA figures for 2007, 2008 and 2009 appear to be incorrect compared to the order of magnitude (billions of litres) of SAPIA figures for 2010 to 2012 and Chevron data for 2012 and 2013 – so year-on-year comparisons are not possible using these figures.

Due to data concerns, the original source of data collation for this sector was approached. Having recently taken over from BP in this regard, Chevron only has data for the last couple of years. SAPIA 2010 and 2011 figures are more in line with Chevron figures, but are still fairly different and heading downward, whereas Chevron 2012 and 2013 data seem to display an upward trend. Chevron, as the data source, is likely the most accurate, and its figures are therefore used as the source of data for this fuel.

Coal

As coal is deregulated, and production and distribution is privately controlled, obtaining supply-side data is difficult. Certain suppliers are prepared to provide some insight, but no clear and replicable figures or data sources exist. There also appears to be a regular turnover of suppliers and industry players, presenting further challenges. A fairly detailed exploration of City Air Quality Department figures, studies and 'spot-checking' reveals that many figures currently presented are fairly inaccurate. However, a detailed study would require numerous resources and is not really warranted here, given the very small percentage of coal in the supply mix (around 1%).

It was therefore decided to rely on information from the distributors. Initially, the idea has been to work with the data from Air Quality – despite being aware of some degree of inaccuracy – as these are recorded annually, providing some degree of systematisation in data-gathering and recording. However, until these figures are a bit more defensible relative to supplier information, they cannot really be used.

Wood

There are no data on wood supply into the city. As this is a growing demand, it may be an area for some further research. However, even more so than coal, wood accounts for a very small proportion of total demand, so additional information and research would be a 'nice-to-have'.

9.2 SECTOR DEMAND

Electricity

Eskom data are presented according to sector allocations. The basis of how this is done is not known. Within municipal redistribution, some analysis of sector electricity demand is done through an exploration of SAP sales by customer category. However, the tariff categories do not neatly align with sector categories in all instances.

Small power users (SPU), large power users (LPU) vs commercial and industrial sectors

These tariff categories do not line up with the sectors. Therefore, allocations draw on detailed studies of data. It was decided to use the sector breakdown allocations contained in the Caroline Martin study,[77] rather than the top-users sector breakdown. Even though the Caroline Martin data are older (dating back to 2007/8 as opposed to the 2011/12 top-users data), the sample size is larger (at 75% of total LPU sales, as opposed to a 38% sample size for top users). After having drawn this information from Martin's study, LPU customers' electricity use was split between commercial and industrial according to the proportional split indicated in the raw 2006/7 electricity sales data received from Martin, which showed that electricity sales were apportioned 67% commercial and 33% industrial.

Residential

This has the closest alignment, and the total domestic figures can be taken to represent the residential sector. However, recent shifts have taken larger housing estates (which can be fairly large consumers of power) out of this tariff category and have put them across into the large power user (LPU) category. An attempt has been made to 'return' this consumption into the residential sector, but in future, some sort of sector tag in the SAP data will be critical for accurate tracking over time.

Low and high-income consumption

In the past, the tariff categories 'credit' and 'prepaid' lined up reasonably with mid to high-income and low-income residential consumers. However, with the push to get all households onto prepaid meter systems, this neat categorisation has broken down. Although some analysis has been done by 'credit' and 'prepaid' tariff, and it can provide some broad indications (i.e. 'credit' category indicates mid to high-income generally, while prepaid is mostly low-income), this can no longer be said to easily represent these different residential categories. Again, at this stage, there is no easy way to undertake this analysis.

77. *Establishing energy benchmarks for commercial buildings in the City of Cape Town*, master's dissertation, June 2011.

Spatial and temporal spread of demand

This can be done only to the broad transmission area. However, indications are that the City will in the near future be able to make substation-level data available via the SAP system. This will add an enormous amount of detail to the current understanding of demand across the city in terms of sectors and income bands.

Liquid fuel

As the reliability of SAPIA data in respect of sector allocations has not really been tested yet, and because the end-use application of liquid fuel is for transport, the Department of Energy's National Energy Balance report, as per protocol, simply records all transport fuels under the sector "Transport". Some breakdown into residential, commercial, industrial and local government sectors is explored in the detailed sector analysis. However, it is also possible that this degree of disaggregation may require special permission from the Department of Energy.

Local government

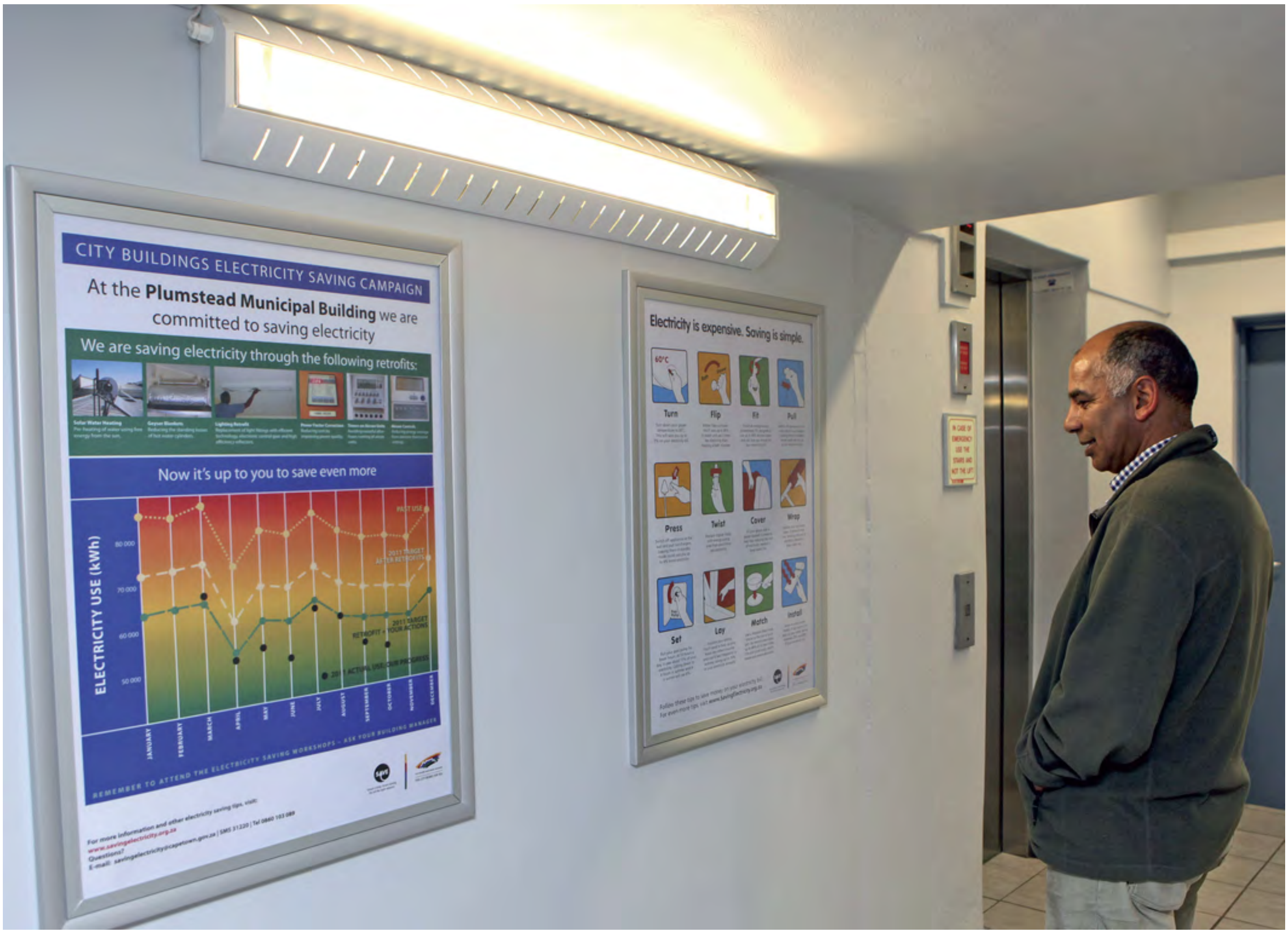
Due to the initiation of programmatic collection of 'bottom-up' metering and monitoring of energy consumption across local government facilities, the City is now able to provide fairly accurate, on-site data for most of its facilities. Where metering is not comprehensive, robust estimations have been made.

The 'bottom-up' metering does not totally align with the City's SAP 'sales' to municipal services, but comes very close. This is confusing, as SAP's internal allocation to end use is very far from aligning with bottom-up monitoring, which begs the question as to how the SAP metering is done. It also means that a call has to be made: Should the energy balance take into account the more accurate (by end-use application) bottom-up meter/monitor figures, or the total SAP sales figure?

For the purpose of this report, we have allocated to sub-sectors on the basis of bottom-up metering, but used the SAP sales total (slightly adjusting the buildings figure, as this contains some estimates) so that the sum of all sub-sectors equals the SAP sales figures.

Some electricity is also supplied to wastewater treatment plants (WWTPs) directly from Eskom. These records are in the WWTP accounts and have been included in the totals, which would explain why total electricity consumption is higher than SAP sales accounts. Eskom also supplies street lighting in Cape Town, which has not been included as a component of local government consumption.

The City will in the near future be able to make substation-leve data available via the SAP system. This will add an enormous amount of detail to the current understanding of demand.



9.3 GLOBAL PROTOCOL FOR COMMUNITY-SCALE GREENHOUSE GAS EMISSIONS INVENTORIES (GPC)

This *State of Energy* report does not represent a detailed greenhouse gas (GHG) emissions report. However, the data have been used to complete the basic-level GPC inventory for local-level GHG reporting. The only difference here from the rest of the report is that emissions relating to transmission and distribution losses (from power station to redistributor) have been taken out from scope 2 electricity-related emissions and are accounted for in scope 3. Thus, for scope 2, total electricity by sector is calculated at the Department of Energy/Eskom emission factor of 0,99 (for kg; 0,00099 for tonnes) for emissions excluding transmission and distribution losses, and for scope 3, the total electricity by sector is multiplied at the emission factor of 0,04 (or 0,00004 for tonnes) to obtain the difference.

The waste figure is based on a GPC/IPCC methodology, but is likely overly simplistic. Details are presented in the figure below.

Waste			
Municipality name:	Cape Town		
Population	3 837 414 (Stats SA Census 2011)		
Waste generated in 2012			
	Mass (t)	**Mass per capita (t)**	
Landfilled waste	1 765 401,68	0,460049836	
Waste type	**Waste fraction**	**Biodegradable portion**	**Dissolved organic carbon (DOC)**
Paper products	0,23	0,4	0,092
Food waste	0,13	0,15	0,0195
Plant debris	0,09	0,2	0,018
Wood/textiles*	0	0,34	0
All other waste	0,55	0	0
Source: Cities for Climate Protection, 2003, p 14.			**0,1295**
* Average of IPCC values for wood (0,43) and textiles (0,24).			
	MCF (methane correction factor)	1	
	DOC (degradable organic carbon) as fluorescence – fraction	0,6	
	F - fraction of methane (CH4) in landfill gas	0,5	
Methane (CH4) generation potential, Lo	0,0518	(t CH_4/t waste)	
Global warming potential of methane (100 years)	25	CO_2 equiv.	
Landfill gas recovery	0		
Long-term GHG emissions 2012	2 286 195	tCO_2e	
Waste generated in 2009			
	Mass (t)	**Mass per capita (t)**	
Landfilled waste	1 250 426,5	0,357561265	
Long-term GHG emissions	1 360 214	tCO_2e	

9.4 SUPPLIER SURVEY OF GRID-CONNECTED SOLAR PHOTOVOLTAIC SYSTEMS IN CAPE TOWN AND SURROUNDS, MAY 2014

Between February and April 2014, Sustainable Energy Africa undertook a brief telephone and internet survey of grid-connected solar photovoltaic (PV) systems in Cape Town in order to gain a sense of the number and size of systems currently connected to the grid. Information was collected from suppliers either telephonically or from their websites. During the survey, it became apparent that there was a general reluctance to provide information, either for commercial reasons or because systems have not been officially approved by the City. The staff conducting the survey considered that there may be double the number of systems than what the survey could identify, and while commercial systems were generally approved by the City, residential systems tended not to be. The survey results, though not considered a reasonable reflection of the actual situation, are presented in the table below.

Installed grid-connected solar PV systems in Cape Town and surrounds, 2014

	Commercial/industrial solar PV systems					Residential solar PV systems		
	Location	**Type of operation**	**Date installed**	**System size (kWp)**		**Location**	**Date installed**	**System size (kWp)**
1	Bracken Gate		2014	100	1	Constantia	August 2013	4,5
2	Cape Town	Retail	2013	108	2	Durbanville	October 2013	4,5
3	Black River office	Office	2013	500	3	Piketberg	November 2013	10
4	Black River office	Office	2014	700	4	Wellington		10
5	Cape Town 7700	Office	2013	61,7	5	Llandudno	November 2013	4,5
6	Somerset West	Wine farm	2013	51	6	Constantia		3,3
7	Cape Town Waterfront	Office		67,9	7	Clanwilliam	September 2013	3,2
8	Cape Town	Office	2010	15	8	Cape Town	June 2013	8
9	Cape Town	Industry	2010	30	9	Hout Bay		5,5
10	Cape Town	Wine farm	2013	60	10	Hout Bay	March 2014	3,3
11	Cape Town	Office	2013	20	11	Contermanskloof	February 2013	3,6
12	Mitchells Plain	Hospital	2013	64	12	Hout Bay	September 2013	4,5
13	Maitland	Industry	2013	30,1	13	Tokai	August 2014	4,5
14	Epping	Industry		80	14	Noordhoek	August 2013	3,6
15	Epping	Industry	2010	29,4	15	Constantia	June 2013	3,8
16	Epping	Industry	2013	50,4	16	Somerset West	February 2014	5
17	Cape Town	School		1,2	17	Newlands	February 2014	4
18	Cape Town	School	2013	2,07	18	Sea Point	October 2013	4
19	Cape Town Westlake	Office	2004	1,8	19	Cape Town	September 2013	4,5
20	Cape Town Wynberg	NGO	2000	2	20	Cape Town	August 2013	10
21	Cape Town Waterfront	Aquarium	2012	5	21	Cape Town	July 2013	3,2
22	Philippi	Office	2011	5,3	22	Cape Town	April 2013	5,5
23	Cape Town	Hotel		30	23	Plumstead	March 2013	4
24	Cape Town	Office	2013	542	24	Newlands	March 2013	4,2
25	Philippi	Warehouse	2013	300	25	Noordhoek	September 2013	7,8
			Total commercial	**2 856,87**	26	Somerset West	July 2013	10,4
					27	Cape Town	August 2013	5,17
					28	Camps Bay	October 2013	4,94
					29	Somerset West	November 2013	4,23
							Total residential	**153,74**
							Total commercial and residential kWp	**3 010,61**

Survey conducted by Ozro Hamblin (intern) from Sustainable Energy Africa, www.sustainable.org.za, 021 702 3622, mark@sustainable.org.za.

CITY OF CAPE TOWN
ISIXEKO SASEKAPA
STAD KAAPSTAD

Making progress possible. Together.