Western Cape Government
Environmental Affairs & Development Planning

BETTER TOGETHER.

ENERGY CONSUMPTION AND CO_2e EMISSIONS DATABASE FOR THE WESTERN CAPE

January 2013

CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACRONYMS

AFOLU	Agriculture, Forestry and Land-Use
CCT	City of Cape Town
CDM	Clean Development Mechanism
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent
CCGT	Combined Cycle Gas Turbine
CH_4	Methane
DEA	National Department of Environmental Affairs
DEADP	Department of Environmental Affairs and Development Planning, Western Cape Government
DME	National Department of Minerals and Energy (now split into the Department of Mineral Resources and the Department of Energy)
DoE	National Department of Energy
EEDSM	Energy Efficiency and Demand Side Management Programme
EF	Emissions Factor
GDP	Gross Domestic Product
Gg	GigaGrammes
GHG	Greenhouse Gas
GJ	GigaJoule
GPC	Global Protocol for Community-Scale Greenhouse Gas Emissions
GVA	Gross Value Added
GWP	Global Warming Potential
HDI	Human Development Index
HFC	Hydrofluorocarbon
HFO	Heavy Fuel Oil
Hh	Household
ICLEI	Local Governments for Sustainability
IDP	Integrated Development Plan
IPCC	Intergovernmental Panel on Climate Change
IPPU	Industrial Process and Product Use
kWh	KiloWatt-hour
LED	Light Emitting Diode
LPG	Liquefied Petroleum Gas
LULUCF	Land Use and Land Use Change and Forestry
N_2O	Nitrous Oxide
NERSA	National Energy Regulator of South Africa
NMT	Non-Motorised Transport
OCGT	Open Gas Cycle Turbine
PFC	Perfluorochemical
SAPIA	South African Petroleum Industry Association
SEA	Sustainable Energy Africa
SF_6	Sulphur Hexafluoride
SWH	Solar Water Heater
T&D	Transmission and Distribution
tCO_2	Tonnes of Carbon Dioxide
TJ	TerraJoule
TSA	Technical Service Areas
UNEP	United Nations Environment Programme
WC	Western Cape
WCG	Western Cape Government
WRI	World Resources Institute

ENERGY AND EMISSIONS REPORT

INTRODUCTION

The Energy Consumption and energy- and waste-related Greenhouse Gas Emissions Database for the Western Cape was commissioned by the Department of Environmental Affairs and Development Planning (DE&ADP) in the Western Cape Government (WCG). This report has two main sections: 1) an energy supply and demand database, including energy-related CO_2e emissions and 2) an energy- and waste-related emissions report. All GHG emissions figures/graphs in the first section are energy-related emissions only; emissions graphs/figures in the GHG Inventory chapter include energy- and waste-related emissions.

The database builds on the Province's pro-active engagement with energy and climate change response action, relating to provincial mandates associated with economic development, planning, transport and environment. It is widely acknowledged that effecting climate change response, as well as managing energy towards reducing poverty and emissions and enhancing security, relies substantially on input and action at the local and provincial government level.

The database has thus been developed to support the strategic intentions of the Western Cape Government, specifically in relation to the Western Cape Climate Change Response Strategy and Action Plan and the White Paper on Sustainable Energy for the Western Cape. It has been designed to meet the following objectives:

1. To provide an overarching energy consumption and carbon dioxide equivalent (CO_2e) emissions inventory. This will build on the data collated for 2004 and facilitate tracking of energy and related carbon emissions over time. It will also deepen the Western Cape Government's understanding, as laid out the in the Provincial Energy Strategy of 2007, of key energy and emissions issues and management priorities; both in terms of sector consumption and geographic distribution of that consumption.

2. To provide a disaggregation of provincial energy and emissions profiles down to the district and local government level, where possible. This disaggregation is intended to enhance local level energy and emissions management and tracking.

3. To contribute to the national efforts underway to build and develop a solid foundation of energy consumption and emissions data towards improved energy planning and climate response action, and the implementation and evaluation of impact.

Note that (as explained further in the Technical Report: Data collection and collation process: Eskom) the provincial level energy consumption figures include those for Eskom; the sector breakdown percentages provided at the district level include Eskom data, but actual Eskom consumption figures at a district level are not provided due to issues of customer confidentiality; and Eskom data is not recorded at the municipal level as Eskom does not collect data on a municipal boundary basis.

Primary energy supply and transformation is the mandate of National Government (in terms of the Energy Act of 2008). The Western Cape is home to some of this activity, notably Koeberg nuclear power station, the Open Cycle Gas Turbine peaking power stations at Gourikwa (Mossel Bay) and Ankerlig (Atlantis), the Darling Wind Farm, the oil refineries, PetroSA and natural gas off the west coast and southern Cape. The WCG can play an important part in facilitating the energy industry in the province, and establishing conditions that encourage renewable energy industrial development. However, uptake into the national energy mix remains the responsibility of national government, guided by the Integrated Energy Plan and Integrated Resource Planning policies.

This assessment has focused on gathering the 'demand-side' energy consumption and emissions data picture and balancing this with the total supply of fuels coming into the province. The electricity mix is taken, in terms of local level energy data protocols, as being a proportion of the national mix in 2009, i.e. 95% coal-generated and 5% nuclear. Any renewable source generation in 2009 was as yet far too small to register in percentage terms in this mix.

While it is relatively easy to get supply-side information, understanding where and how these fuels are used is more difficult, but obviously of enormous importance when considering efficiency and demand-side management options, and exploring and modelling future demand.

The Greenhouse Gas (GHG) Emissions (energy- and waste-related) Inventory component of the database has drawn on international protocols, primarily the Global Protocol for Community GHG emissions released by C40, ICLEI and WRI with support from the UN-HABITAT, UNEP and the World Bank, relating to community level inventories, in order to ensure compatibility of the data with national and international inventories and reporting standards.

Data has been collected with a particular set of sustainable energy indicators in mind. These indicators draw on local, national and international practice and provide measures against which to track and monitor energy security, energy access and equity/poverty issues, emissions levels associated with energy consumption and sustainable energy development.[1]

The emphasis of this database report is to provide a concise account of the energy consumption and CO_2 emissions 'picture' and how this picture was derived. The Energy Consumption and CO_2e Emissions Database includes:

1. Technical report: outlining the database development and methodological approach (to support the replication of the exercise in years to come and contribute to national database, notably demand-side, development)
2. Provincial energy consumption and CO_2 emissions analysis and associated data sheets
3. District energy consumption and CO_2 emissions analysis
4. Municipal energy data sheets
5. A GHG Emissions Inventory and analysis report
6. A compilation of the digital database records

[1] State of Energy in South African Cities 2006 by Sustainable Energy Africa

TECHNICAL REPORT: DATABASE DEVELOPMENT AND METHODOLOGICAL APPROACH

Establishing method protocols, a baseline year and scope of the study

The database approach was developed in close consultation between provincial and national government[2]. It was decided to use **2009 as a baseline year**. This was due to the fact that liquid fuel use data by municipal boundary, as opposed to magisterial district boundary, had been developed for 2009.[3] The year 2009 also represents a 5-year time-span since the collection of the previous provincial state of energy and energy strategy, which was completed in 2008 and based on 2004 data.

In terms of existing protocols for regional energy data collation, power generation for the national grid is 'excised' from the local picture, even if this power is generated at the regional level, in order to avoid double accounting. Therefore inputs into Koeberg and Eskom's two Open Cycle Gas Turbine (OCGT) peaking power stations and the output of Darling Wind Farm, for example, are not included, as they are primary energy inputs that are recorded at the national level. Secondary power consumed in the province (in this instance electricity) is the focus for measurement. Similarly, provincial energy-use data does not include the amount of refined oil entering the country through ports located in the province. These protocols may in time be challenged if smaller-scale, distributed power systems become a regular part of the provincial energy landscape. However, for the purposes of this study the existing protocols are followed. The energy industry of the province will be referred to in the discussion.[4]

A full GHG Emissions Inventory includes emissions from energy, waste, agriculture, forestry and land-use change. The scope of this study was discussed at length. In light of the resource and data constraints, it was decided not to include emissions from agriculture, land-use change and forestry, as this data was lacking or negligible. This study therefore focuses on energy-use-related emissions, with a solid waste emissions approximation only.

As noted in the introduction, data was collected with a particular set of sustainable energy indicators in mind. These indicators draw on local, national and international practice and provide measures against which to track and monitor energy security, energy access and equity/poverty issues, emissions levels associated with energy consumption and sustainable energy development.

The data collection and collation process

Supply and demand-side energy data was collected. Demand-side refers to the energy end-users. These are largely the economic sectors within the energy picture, such as the residential sector, transport sector, industry, etc. In balance is the supply-side sector, which refers to the classifications of both primary and secondary energy types that are distributed to the demand-side for use. These include coal, electricity, renewable energy, etc.

Data development involved 'field' research in the form of a questionnaire process to obtain information from municipalities, direct contact with distributors/consumers (in the case of coal), and desktop research to draw on nationally available data. The table below provides an overview of data sources.

[2] Consultations were held with the Department of Environmental Affairs, Department of Energy, NERSA (National Energy Regulator of SA) and Eskom Western Cape Customer Services.
[3] SEA undertook this time consuming and cumbersome exercise in 2011 in order to generate a resource for municipalities across the country.
[4] It should be noted that the diesel consumed in the Gourikwa power station was taken out of Mossel Bay diesel figures; however this figure has not been established for the Ankerlig power station and this amount has yet to be deducted from Cape Town figures.

Table 1: Supply-side energy data sources

Fuel Type	Data Source
Electricity	Eskom
Liquid fuel	South African Petroleum Industry Association (SAPIA) via the Department of Energy
Coal	Distributors, consumers, Western Cape Government Air Quality Management Unit
Renewable energy/ solar water heater/ energy efficiency implementation	Local municipalities

Table 2: Demand-side energy data sources

Sector	Data Source
Residential	Municipal electricity distribution; Eskom electricity distribution; SAPIA data on paraffin and LPG (Liquid Petroleum Gas) use; StatsSA household studies; Department of Energy Free Basic Electricity data; engagement with NERSA to cross check results[5]
Commercial	Municipal electricity distribution; Eskom electricity distribution; NERSA (National Energy Regulator of South Africa) engagement
Industry	Municipal electricity distribution; Eskom electricity distribution; NERSA engagement; coal distributors; large industries; Provincial Air Quality Department
Agriculture	Municipal electricity distribution; Eskom electricity distribution; NERSA engagement
Transport	SAPIA; eNaTiS (electronic national administration traffic information system), StatsSA household travel surveys; Eskom electricity distribution
Overall	The City of Cape Town State of Energy Report (2011); municipal Integrated Development Plans

A detailed account of these data sources and the method of data collection and collation are provided below.

National data

National data relating to energy was derived from the Department of Energy's (DoE) South African Energy Synopsis 2010. This is based on the Energy Balance data for 2006. Although 2009 energy data is largely available, the DoE is still making a final determination on aspects of this and it could not therefore be used for this study.

National GHG emissions data has been based on that recorded in South Africa's Second National Communication under the United Nations Framework Convention on Climate Change (2011). This report has two sections: an energy report and an emissions report. In the first section, the national per capita figure used is based on emissions from energy supply and consumption. The second part of the report uses the national figure that includes waste emissions, as the local-level emissions covered in this report includes that from waste.

Municipal data

Municipal questionnaire

A questionnaire was developed and distributed to all local municipalities (see Appendix 1). A number of steps were taken to ensure that the questionnaire was attended to:

1. DEADP officials contacted all municipalities via the mayor and municipal manager to inform them of the study and request their participation. The advantages of participation were outlined, i.e. detailed data disaggregated to support local level energy and emissions management
2. The questionnaire was sent from the Provincial DEADP office and directed at the municipal manager, mayor and the delegated municipal representative

[5] NERSA have not yet produced a report for 2009 due to very low levels of data return from Municipal Electricity Distributors, so this was an informal engagement with preliminary data results that they have.

3. The service providers made contact with municipal representatives at the start of the study and maintained contact during the course of data collection. In some instances a great amount of effort was required to prioritise such a task in under-capacitated municipalities.

There was a wide spectrum of municipal response rates; from very weak to comprehensive, depending on staff capacity (see **Appendix 4: Institutional Capacity in Local Municipalities**). The exercise highlighted that follow-up phone-calls are imperative. They help to clarifying data and data issues and ensure a better response rate. Unsolicited information may also be supplied, which may assist in guiding future data-collection exercises along municipal needs and data availability. Telephonic conversations also highlighted certain changes that could enhance and refine the questionnaire. These are included in **Appendix 1: Questionnaire method**.

The questionnaire requested data covering socio-economic and demographic data, electricity distribution, electricity access, renewable energy/solar water heater/energy efficiency/demand side management implementation, transport and governance issues.

One persistent challenge to local level, demand-side data collection is that municipalities all have different customer categories and struggle to disaggregate their electricity distribution data into sectors (or sub-sectors, such as income categories amongst residential customers). The understanding is that NERSA is initiating a process of requiring municipalities to report to sector distribution, so this may improve over the coming years. In general, energy data management requires support from a range of government actors, for example NERSA, Western Cape Government, national Department of Energy, etc. It is important to note when reading the data that municipalities are usually not able to provide electricity-supply sector allocations (as they distribute according to tariff bands and geographic areas that do not align neatly with sectors) and thus the electricity sector allocations for municipalities DO NOT add up to the total of municipal electricity distributed. Please see **Appendix 2: Eskom Sales to Redistributors vs Municipal Total Sales** for more detail on this discrepancy.

Gathering data on renewable energy, solar water heater, energy efficiency and demand-side management implementation was also difficult, although it should be noted that very little had taken place in this area by 2009 (see **Appendix 4: Institutional Capacity in Local Municipalities**). Municipalities participating in national programmes (the Department of Energy's Municipal Energy Efficiency and Demand Side Management programme and Eskom's Integrated Demand Management programme) around 2009 will start to generate this information shortly, which will contribute to any future study.

Data-collection alignment

Some municipalities commented that they are extremely busy and are frequently approached for the same information by different persons and organisations, or different departments within the same organisation. The sense was that the same information gets supplied to NERSA every year. Ideally NERSA would be a source of local level data and they are actively working on this[6]. NERSA data did provide a useful cross-check, though the data was not used, as it had not been published officially.

StatsSA

Municipal-level household data was only available from StatsSA for 2007, in the form of their Community Survey 2007, but data was available at a provincial level for 2007 and 2009 in the General Household Surveys. The difference between the 2007 and 2009 provincial data was used to calculate the margin of error in using the 2007 municipal data. The margin of error is 3.5%. It must be noted that 2007 population figures were used, as these were the latest reliable municipal-level statistics. Therefore all per capita figures may be slightly skewed, but are still useful when comparing across municipalities.

StatsSA data also provided figures on the mode of transport to work by income group. This data is only available at a provincial, rather than district or municipal, level.

[6] NERSA have recently employed some 20 new data gatherers to reinvigorate the data collection capacity of national government.

Population growth calculation

Calculation used to calculate population growth between 2001 (StatsSA Census) and 2007 (StatsSA Community Survey):

[(pop. at end year/pop. at start year)^(1/no. of years elapsed) – 1]*100

Eskom electricity data

Eskom does not collect data on a municipal boundary basis, but rather in line with their Technical Service Areas (TSAs). However, in response to this data request, the Customer Services Department, with the technical support of the Modelling department of the Western Cape Region, assisted the study by pioneering a substantial new data set that brought together the data disaggregated by sector for all TSAs falling into the Western Cape Province. The data also involved some manipulation in order to bring the TSA information in line with the geopolitical district boundaries.

This has contributed enormously to the ability of this study to provide a detailed level of geographic and sector disaggregation.

Due to constraints with the availability and requirements around the publishing of the Eskom data, the Eskom data is reported on in the following manner:

- For the provincial energy profile, the Eskom figures are included for the total energy baseline as well as for the sector breakdown at a provincial level.
- At a district level, the Eskom data together with the municipal data, is presented as a percentage contribution according to sectors, but the actual figures will not be published
- At a local municipal level, the electricity information will only be for the municipal supply and will not include any Eskom data.

The relevant tables in the report will be labelled as to whether and how the Eskom data has been included the analysis.

SAPIA liquid fuel data

This data is housed with the national Department of Energy (DoE). As of 2010, the data is less readily available at a disaggregated scale due to a ruling by the Competition Commission. DoE will, however, consider supplying the data under certain circumstances.[7]

SAPIA data is collected on a magisterial district basis. Prior to this study, Sustainable Energy Africa undertook a lengthy exercise to manipulate the data into the geopolitical municipal boundaries in order to provide a liquid fuel use tool for municipal energy and GHG planning, based on 2009 data. This was a strong motivator for setting the baseline year as 2009. This tool assisted the study, which would otherwise have had to undertake this exercise, although the experience was that this exercise also assisted in refining the tool.

DoE liquid fuel data does have retail-level disaggregation. This is able to show the amount of a particular fuel sold to, say, the commercial sector, the agricultural sector, etc. Unfortunately, there are certain retail trade categories that are more difficult to assign to a sector, e.g. general dealers, retail – garages, etc. The bulk of liquid fuel in these categories was assigned to the transport sector. Sector liquid fuel use allocations were made on the following basis:

- According to a National Treasury Report (2003) over 70% of paraffin is consumed by households. Due to the age of this data and uncertainty as to the apportioning of the remaining paraffin, it was decided to assign paraffin use entirely to the residential sector.
- There have been no detailed studies on LPG use in the country. In considering how to apportion liquid fuel, this study drew on LPG allocations in the City of Cape Town LTMS (Long-term Mitigation Scenarios) work: 25%/25%/50% to the residential/ commercial/ industrial sectors respectively[8]. However, more research is required in future.
- Heavy Fuel Oil (HFO) was allocated to the industrial sector.

[7] It is believed, based on the work noted in the footnote below, that the SAPIA data is collected on the financial rather than calendar year. This would need to be clarified.

[8] Based on communications with the LPG retail industry

- Petrol and diesel were mainly allocated to the transport sector. Aside from a few processes using diesel generators, the main use for these fuels is in transport; regardless of the sector (e.g. petrol use in the commercial sector could be used for couriering services). The Air Quality data for the City of Cape Town does show diesel use in industry, but the process use is not clear. If this was clarified, the data may be worth developing and utilising for greater degrees of disaggregation. However at this stage there is no consistent methodology to do this.
- It should be noted that consumption of diesel by Eskom at its two peaking Open Cycle Gas Turbine power stations in the Western Cape has been excluded from the study (i.e. subtracted from the SAPIA data). This is to avoid double accounting: the fuel is used to generate electricity, which is accounted for in the electricity use data.[9]
- Natural gas was assigned the same sector-use split as LPG and the same conversion factors were used. Conversion factors for litres to GigaJoules for natural gas were not available; only kilogramme or metres cubed to GigaJoule.
- Fuels from the Department of Energy data set that were not included in this analysis include asphalt, paraffin wax, automotive oil, grease, solvents, industrial oil and process oil. This is because these products are used for construction, lubrication, insulation, etc; and not as an energy source.

eNaTiS (National Traffic Information system): vehicle numbers and modal split

Vehicle numbers are all originally sourced from eNaTiS figures, whether from the municipality or eNaTiS directly. The numbers given are not according to municipal area, but by registering authority. In discussions with municipalities it appears that some vehicle owners may take their cars to registering authorities in the Northern Cape, which is seen as cheaper, or they do not live in the area in which their vehicle was registered. Data that is more useful to municipalities would be vehicle type by owner's address or municipal area of owner's residence.

Indicators that are useful to track over time are the number of vehicles per population and the number of public vs. private vehicles (assigned as in the table below). This will give a rough indication of modal split, i.e. public vs. private transport.

Table 3: eNaTiS vehicle type classification

eNaTiS category	Assumed vehicle type
No. of heavy passenger (>12) vehicles	Public
No. of minibuses	Public
No. of light passenger (<12) vehicles	Private
No. of motorbikes	Private
No. of other vehicles (special and unknown)	Other
No. of heavy and light load vehicles	Freight

Vehicle numbers by registering authority could not be obtained for 2009. The earliest figures were from September 2011. The vehicles per capita figures are therefore for 2011[10].

[9] Establishing the amount of diesel consumed by Gourikwa in 2009 was difficult: the DoE liquid fuel figures, when compared to similar towns (and a comparison of petrol-diesel proportions) indicated that some 100 million litres were used in power generation; this was cross checked with the Eskom Annual Report for 2009 and with PetroSA directly (telephone call Feri Stark, PetroSA, September 2012). Articles relating to the power station's consumption were also followed up (Eng News, etc). An Eskom report notes that the OCGT technology used at Gourikwa around 160 tonnes of diesel/hour. Converted to litres, this is around 190 000 litres/hour. If running at 2 hours a day, this would be 380,000 litres per day and approx 136 million litres a year; at 1 hour a day more like 70 million litres per year; an Engineering News article refers to an anticipated use at Gourikwa of 60 000t of liquid fuel a year (running for 2 hours per day), which comes to 71 million litres per year.
The following emerged: Eskom Annual Report, should be the official figure, however, it indicated that consumption in 2009 was around 28 million litres, but noted that this was a 92% decline from 2008 (in region of 360 million litres). Given the liquid fuel data (at 140 mill litres) this study made the assumption that DoE liquid fuel figures must include a portion of 2008 and 2009 (financial year, rather than calendar year). Given this, a realistic amount to deduct would be the 100 million litres.

[10] Population figures for 2011 were obtained by applying the population growth rate calculated from the StatsSA Census 2001 and the StatsSA Community Survey 2007 to the StatsSA 2007 figures.

Coal data

It is a difficult and lengthy process to obtain coal data at the local level due to this fuel being unregulated. The National Department of Mineral Resources apparently does not keep records of coal purchases and sales at coal yards or local coal distributors,[11] but only has information on the export and sales from coal mines. Coal mine sales data, furthermore, are not broken down by geographic area, but by end-use, e.g. electricity generation, cement production, domestic, etc. The details and location of buyers, coal yards included, are not recorded.

Local industrial coal data was made available by the provincial air quality department, which requires industries to register the amount and types of fuel used in order to be licensed. Previous energy studies (for the City of Cape Town) had found this data to be under-reported, so a process of cross-checking was undertaken. This involved obtaining distribution data from leading distributors, as well as sourcing consumption figures of the largest industrial consumers directly from the companies involved, or via their annual reporting processes. The final coal figures are believed to provide a reasonably good estimate of consumption in the province and provide the first reasonable level of district-level disaggregation. Unfortunately coal data will always be slightly unreliable. A detailed overview of how the data was assembled is available in **Appendix 3: Coal data methodology for the Western Cape**.

Waste

Data on the amount of solid waste landfilled within each municipality was supplied by the respective municipalities. There is a deep concern on the accuracy of this data, as it is known that many municipalities do not have weighbridges at their landfill sites. Municipalities were asked to indicate if all solid waste generated within their geopolitical boundaries was also managed within the same municipality. This was meant to determine the location of GHG emissions that might be associated with this waste. Waste was characterised according to studies that were done for DEADP in the past. District average figures were used in this characterisation.

Emissions associated with land-filled municipal solid waste (MSW) in the inventory year, 2009, were calculated using the following equation (based on IPCC Good Practice Guidance, 2000) for each municipality.

Equation:

$$GHG\ emissions\ (CO_2e) = M_{waste} * L_0 * GWP\ of\ CH_4 * (1-f_{rec})$$

Where:

$GHG\ emissions\ (CO_2e)$	=	*Total CO_2e emissions in metric tons*
M_{waste}	=	*Mass of MSW landfilled in 2009 (tons)*
L_0	=	*Methane generation potential(see below)*
$GWP\ of\ CH_4$	=	*21*
f_{rec}	=	*Fraction of methane (CH_4) recovered at the landfill site (energy recovery or flared)*

The methane generation potential (L_0) of MSW is the emission factor used to specify the amount of methane (CH_4) that can be generated by a ton of solid waste. The L_0 is dependent on the amount of degradable organic carbon (DOC) present in the waste stream. Waste characterisation (see table below) for the different municipalities was done using data from studies that have been previously done for the Department of Environmental Affairs and Development Planning of the Western Cape Government.

[11] Personal communication with Mr. Khangele from Department of Mineral Resources

Table 4: Waste characterisation per district municipality[12]

Waste Characterisation per District Municipality						
Waste Type	**Cape Winelands**	**Central Karoo**	**City of Cape Town**	**Eden**	**Overberg**	**West Coast**
Paper products	39%	28%	23%	18%	22%	23%
Food waste	10%	10%	13%	8%	24%	26%
Plant debris	9%	4%	9%	10%	13%	13%
Wood / Textiles	4%	6%	0%	7%	6%	4.60%
All other waste	38%	52%	55%	57%	35%	33.40%

Methane Generation Potential:

$L_0 = MCF * DOC * DOCf * F * 16/12$

Where:

MCF	=	*Methane correction factor [assumed all landfills are managed (1)]*
DOC	=	*Degradable organic carbon*
DOC_f	=	*Fraction of DOC that is ultimately degraded (assumed 0.6)*
F	=	*Fraction of CH_4 in landfill gas (usually taken to be 0.5)*
$16/12$	=	*Stoichiometric ratio between methane and carbon*

Global Warming Potentials

The inventory process considered the following greenhouse gases: carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). The Global Warming Potential (GWP) of these gases was used to convert the quantified emissions into the standard unit of metric tons of CO_2-equivalent (tCO_2e). Note that the inventory does not include HFC, SF_6 and PFC emissions. Global Warming Potentials are a quantified measure of the globally averaged relative impact of a particular greenhouse gas (GHG). GWP values facilitate the direct comparison of the impacts of emissions of different GHGs. Carbon dioxide was chosen as the reference gas and has a GWP of 1. Conversion of GHGs into CO_2 equivalents was done according to the IPCC requirements as listed below.

Table 5: Global warming potential of greenhouse gases

Greenhouse Gas	Chemical formula	IPCC GWP
Carbon dioxide	CO_2	1
Methane	CH_4	21
Nitrous Oxide	N_2O	310

Part of the reasoning for focusing on only energy and solid waste emissions is that, in the bigger picture, fossil fuel related CO_2 and solid waste related CH_4 comprise the vast majority of the country's climate change inducing emissions, with any other emissions contributing marginally to the overall inventory. Additionally, the inventory does not include emissions related to the production of most goods bought or consumed in the province (i.e. Industrial Processes and Product Uses).

Municipal-specific data notes

This technical report has attempted to cover all overarching data areas and methods used. However, some specific decisions and data sources arose within each municipality. These are recorded and are available on each Municipal data overview sheet.

[12] Report on the Waste Characterisation Survey undertaken at selected landfill sites in the West Coast District, PD Naidoo & Associates, 2007; Waste Characterisation Surveys in the Cape Winelands District Municipality, JAYMATEnviro Solutions CC, 2007; Waste Characterisation Surveys in the Central Karoo District Municipality, JAYMATEnviro Solutions CC, 2007.

Energy conversion and greenhouse gas emission factors used

Emission factors

Energy emissions from all sources of combustion were estimated using the Tier 1 Method where CO_2 emissions from fuel combustion are estimated by multiplying the amount of fuel used (taken from national/municipal statistics) with a fuel-specific default CO_2 emission factor (EF). South Africa's default emission factors used in the calculations are listed in the table below – these emission factors are according to the IPCC country-specific emission factors. We recognise the fact that this method, although accurate for CO_2 emissions, is however less accurate for non-CO_2 gases, because emission factors for these gases may depend considerably on the combustion technology and operating conditions.

Table 6: Greenhouse gas emission factors for South Africa

Fuel Type	Unit	CO_2	CH_4	N_2O	Total tCO_2e	Reference
		tCO_2e per unit				
Diesel	litres	0.0026870	0.00000362600	0.000021760000	0.002702	www.emissionfactory.com (using 4th Assessment Report GWP)
Petrol	litres	0.0022640	0.00000032670	0.000000019600	0.002277	www.emissionfactory.com (using 4th Assessment Report GWP)
Aviation Gasoline	litres	0.0021920	0.00000031310	0.000000018780	0.002205	www.emissionfactory.com (using 4th Assessment Report GWP)
Jet Kerosene (Jet Fuel)	litres	0.0025010	0.00000034980	0.000000020990	0.002516	www.emissionfactory.com (using 4th Assessment Report GWP)
Illuminating Paraffin	litres	0.0025620	0.00000035640	0.000000021380	0.002577	www.emissionfactory.com (using 4th Assessment Report GWP)
Heavy Furnace Oil	litres	0.0029530	0.00000038150	0.000000022890	0.002968	
Electricity	kW h	-	-	-	0.001030	Eskom Annual Reports, 2011 (excluding T&D losses)
Natural Gas	litres	0.0020090	0.00000017900	0.000000003580	0.000002	www.emissionfactory.com (using 4th Assessment Report GWP)
LPG	litres	0.0016180	0.00012820000	0.000002565000	0.001622	www.emissionfactory.com (using 4th Assessment Report GWP)
Coal (Bituminous)	kg	0.0026250	0.00000002670	0.000000040050	0.002810	www.emissionfactory.com (using 4th Assessment Report GWP)
Anthracite	kg	0.0000001	0.00000000001	0.000000000002	0.002643	www.emissionfactory.com (using 4th Assessment Report GWP)
Marine Fuels (Diesel?)	litres	0.0027667	0.00000300000	0.000289800000	0.003060	

Energy conversion factors

All conversion factors relating to the study are available in the electronic database. Below is the Energy Conversion factors used to convert original units of fuel (e.g. litres, kg, etc) into GJ and the associated source of that factor.

Table 7: Energy conversion factors

Energy Source	Conversion	Units	Source
Electricity	0.0036	GJ/kWh	Energy Information Administration, USA, 2001
Coal (bituminous)	0.031	GJ/kg	Energy Information Administration, USA, 2001
Heavy Furnace Oil	0.04	GJ/litre	Energy Information Administration, USA, 2001
Diesel	0.037	GJ/litre	Energy Information Administration, USA, 2001
Paraffin	0.036	GJ/litre	Energy Information Administration, USA, 2001
Petrol	0.034	GJ/litre	Energy Information Administration, USA, 2001
LPG	0.0268	GJ/litre	The South African Pipeline Gas Association
Jet Fuel	0.04315	GJ/litre	BP Products handbook.
Aviation Gas	0.04465	GJ/litre	BP Products handbook.
Gas (Natural)	0.0268	GJ/litre	Set to same as LPG

Conclusion

The exercise of obtaining local level energy data is extremely positive in terms of developing an increasing understanding of what is available in terms of national data sets. Once NERSA is able to streamline their collection process from distributors, this will virtually take away the need to gather data municipality by municipality. However, local engagement, although dreaded by over worked local officials, is useful in terms of developing a real feel for things, garnering snippets relating to local capacity and EEDSM (Energy Efficiency and Demand Side Management) work. Greater alignment can speed this up for all parties.

As local EEDSM and SWH uptake increases, the challenge will be to develop a system that can systematically record the impact of this work. This is being explored by national government in partnership with SALGA and 5 pilot municipalities, looking at a decomposition methodology, but a 'bottom up' recording system for municipalities is worth consideration by Province.

The issue of calendar year versus financial year arose during the exercise. It was agreed (with NERSA, province, etc) to pursue the calendar year (in line with international protocols), but it will take some time to ensure that all data sets align with this. Although this is often not much of an issue, it can become one when substantial disruptions, such as blackouts or economic shocks, take place (an important case in point is liquid fuel for peaking station in Mossel Bay – the difference in consumption between 2008 and 2009 being 92%).

Provincial energy balance

Table 8: Energy use by fuel type by sector[13]

Fuel unit	Electricity (kWh)	Coal (kg)	Petrol (lit)	Diesel (lit)	Paraffin (lit)	LPG (lit)	Natural Gas (lit)	HFO (lit)	Jet Fuel (lit)	Aviation Gas (lit)	Int Marine (lit)	Total (GJ)
Total supply	80 825 972	74 587 189	58 588 891	49 016 902	2 642 124	4 899 600	56	4 583 134	18 941 997	94 407	44 817 995	338 998 268
Total final consumption	80 945 003	74 587 189	58 588 891	49 016 902	2 642 124	4 899 624	56	4 583 134	18 941 997	94 407	44 817 995	338 998 268
Industry Sector	31 259 014	74 587 189				2 449 812	28	4 583 134				112 879 177
Transport Sector	1 421 326		58 588 891	49 016 902					18 941 997	94 407	44 817 995	172 881 519
Agriculture	4 698 001											4 698 001
Commerce and public services	14 434 987					1 224 906	14					15 659 907
~ Local government	*1 244 629*											*1 244 629*
Residential	24 836 951				2 642 124	1 224 906	14					28 703 995
Difference = losses and unaccounted for	-119 031	0	0	0	0	-24	0	0	0	0	0	-119 055

[13] Local government vehicle fleet fuel consumption is captured under the transport sector

Energy use within the Western Cape

Table 9: Energy use by fuel within district and local municipalities

NOTE:All municipal and district electricity figures exclude Eskom figures. However, the provincial totals (final row) include Eskom electricity figures.

District	Municipality	Electricity	Coal	Petrol	Diesel	Paraffin	LPG	Natural gas	HFO	Jet Fuel	Aviation Gas	Int Marine	Municipal total (GJ)
Cape Town Metro	City of Cape Town	37 973 155	3 055 991	41 620 196	30 064 496	2 034 767	3 748 138	0	3 967 139	18 338 382	46 892	44 815 082	185 664 237
Cape Town subtotal	**Cape Town**	**37 973 155**	**3 055 991**	**41 620 196**	**30 064 496**	**2 034 767**	**3 748 138**	**0**	**3 967 139**	**18 338 382**	**46 892**	**44 815 082**	**185 664 237**
Eden	Bitou	385 311	0	632 581	313 006	4 992	0	0	0	0	0	0	1 335 890
	George	1 685 556	0	1 317 141	751 539	17 031	0	0	3 952	377 911	11 049	0	4 164 181
	Kannaland	174 600	0	106 801	151 376	0	0	0	0	0	0	0	432 777
	Knysna	686 715	0	632 581	313 006	4 992	0	0	0	0	0	0	1 637 294
	Hessequa	305 440	0	471 753	360 352	1	0	0	0	0	0	0	1 137 547
	Mossel Bay	1 106 653	0	1 917 367	5 218 842	231 939	1 139 123	0	494	47 239	6 089	2 913	9 670 658
	Oudtshoorn	579 554	0	746 025	343 480	2 546	0	0	494	51 544	3 506	0	1 727 149
Eden subtotal	**Eden**	**4 923 829**	**2 112 247**	**5 824 249**	**7 451 602**	**261 502**	**1 139 123**	**0**	**4 941**	**476 694**	**20 644**	**2 913**	**22 217 743**
Central Karoo	Beaufort West	207 062	0	590 252	1 484 658	127	0	0	0	0	1 659	0	2 283 758
	Laingsburg	23 802	0	161 836	84 542	0	0	0	0	0	0	0	270 180
	Prince Albert	0	0	54 441	107 680	158	0	0	0	0	0	0	162 278
Karoo Subtotal	**Karoo**	**230 864**	**5 766**	**806 528**	**1 676 881**	**285**	**0**	**0**	**0**	**0**	**1 659**	**0**	**2 721 982**
Overberg	Cape Agullhas	234 720	0	199 113	131 573	1 425	0	0	142	62 766	0	0	629 739
	Overstrand	796 045	0	905 178	400 162	11 893	0	0	284	10 199	0	0	2 123 762
	Swellendam	166 860	0	177 260	148 963	2 320	0	0	0	5 492	766	0	501 660
	Theewaterskloof	221 628	0	874 497	779 501	10 681	0	0	2 417	10 199	0	0	1 898 923
Overberg subtotal	**Overberg**	**1 419 253**	**294 159**	**2 156 046**	**1 460 198**	**26 319**	**0**	**0**	**2 844**	**88 657**	**766**	**0**	**5 448 243**
West Coast	Berg River	266 434	0	397 706	351 634	2 806	0	0	0	0	0	0	1 018 580
	Cederberg	205 485	0	204 937	465 565	15 373	0	0	1 254	0	0	0	892 614
	Matzikama	236 567	0	339 416	630 364	4 240	0	0	0	0	0	0	1 210 587
	Saldanha Bay	841 086	0	1 005 806	1 253 753	85 509	0	0	199 713	43 872	0	0	3 429 738
	Swartland	649 235	0	775 991	1 522 958	169 366	0	0	120 083	4 592	2 676	0	3 244 900
West Coast Subtotal	**West Coast**	**2 198 807**	**64 296 666**	**2 723 855**	**4 224 274**	**277 294**	**0**	**0**	**321 049**	**48 464**	**2 676**	**0**	**74 093 085**
Cape Winelands	Breede Valley	1 142 791	0	624 385	1 021 747	22 695	0	0	23 279	0	1 853	0	2 836 749
	Drakenstein	2 619 982	0	1 703 942	1 475 454	4 163	66	45	115 654	0	0	0	5 919 307
	Langeberg	1 037 749	0	428 472	246 262	897	5 923	0	38 083	0	3 209	0	1 760 596
	Stellenbosch	1 342 049	0	2 074 679	797 356	3 072	6 374	11	100 168	0	15 915	0	4 339 624
	Witzenberg	651 903	0	626 539	598 634	11 130	0	0	9 977	0	794	0	1 898 976
Winelands subtotal	**Winelands**	**6 794 474**	**4 822 360**	**5 458 017**	**4 139 452**	**41 957**	**12 363**	**56**	**287 161**	**0**	**21 771**	**0**	**21 577 612**
TOTAL by fuel	**Total (GJ)**	**81 022 902**	**74 587 189**	**58 588 891**	**49 016 902**	**2 642 124**	**4 899 624**	**56**	**4 583 134**	**18 952 197**	**94 407**	**44 817 995**	**339 205 421**

Introduction

The Western Cape Province comprises 5 district municipalities, 24 local municipalities and one metropolitan area (Cape Town). The population of the province in 2007 was 5,278,585 and the GDP for the baseline year of this study, 2009, was R 237.6 billion; comprising approximately 10% of the national figure.

The province is dominated by the City of Cape, with 66% of the resident residing there and 74% of GDP being derived in this intensive node.[14] Cape Town's economy is based increasingly on service sectors (relatively less energy intensive), some manufacture, government services and construction. The West Coast is home to large industrial activity (iron and steel and mining industry); however this district only contributes some 5% to provincial GDP (while accounting for 25% of the provincial energy consumption). The Cape Winelands district contributes in terms of light industry and agri-processing; and beyond this the province is increasingly rural in character. Along the South-East coast and the N2 highway, however, there are a number of larger towns. George is the second-largest town after Cape Town and Mossel Bay has a heavy industrial base. The towns of Knysna and Plettenberg Bay (Garden route) are a tourist hub.

The report provides a brief energy picture for the Western Cape Province and highlights key areas or issues for attention.

The energy picture

Detailed energy 'balance' sheets were provided above. Below is a synopsis of the data picture.

Table 10: Key sustainable energy indicators in the Western Cape Province

Indicator	Unit of measure	Provincial Value 2009	National Value*	Province as % national
Total energy consumption	**GJ**	**339,117,323**	**2,627,000,000**	**13**
Total energy related GHG emissions	**tCO_2e**	**41,303,482**	**380,988,000**	**11**
Energy consumption per capita	GJ/capita	64	53	-
GHG emissions per capita	tCO_2e/capita	8	7.7	-
Energy consumption per GDP (R' mill)	GJ/GDP	1, 428	1, 094	-
GHG emissions per GDP (R' mill)	tCO_2e/GDP	178	159	-

*Source: *Department of Energy: South African Energy Synopsis 2010: data for 2006 only/SA's 2nd National Communication, 2011, data for 2000 only*

At the time of report completion, the DoE were still finalising the national energy balances for 2009; provincial balances have also not been part of these data sets since roughly the year 2000. Therefore, it is difficult to know whether provincial figures relative to national totals are still accurate in today's terms. At a glance, the Western Cape energy consumption and emissions output is in line with its relative population and economic size (these being around 10-11% of national, with energy at 13% and emissions at 11%). Relative consumption of energy per capita is slightly higher than the national average, as are carbon emissions per capita and the province appears to have a slightly higher emissions level per unit of economic value generated.

[14] "City of Cape Town District Fact Sheet" by the Western Cape Destination Marketing Investment and Trade Promotion Agency - South Africa

Energy by municipal district

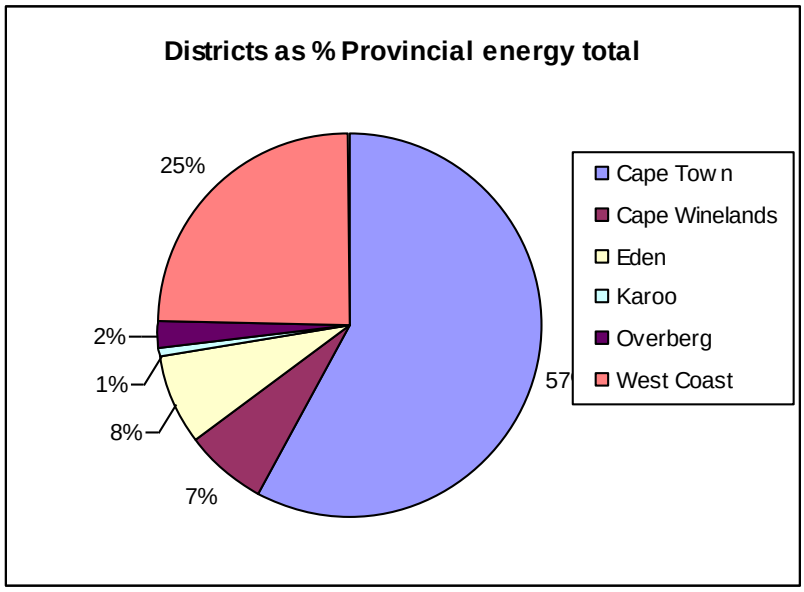


Figure 1: Energy use by district/metro in the Western Cape Province

The picture is dominated by the Cape Town metro, which accounts for nearly 60% of all energy used. This is in line with population and economy as a proportion of the province; 66% and 74% respectively. It also indicates the energy efficiency achieved in this urban area; for though it contributes to 74% of the province's GDP it accounts for only 60% of the province's energy use. The more energy-intense, heavy industry of the West Coast (notably the iron and steel and cement/sand industries) brings this otherwise relatively less populated area of the province in as the second-highest energy consuming area. In general, the emissions per capita in each district come in at just below the national average, with the industrial activity of the West Coast pushing this up on the provincial-wide scale.

Energy consumption by fuel type

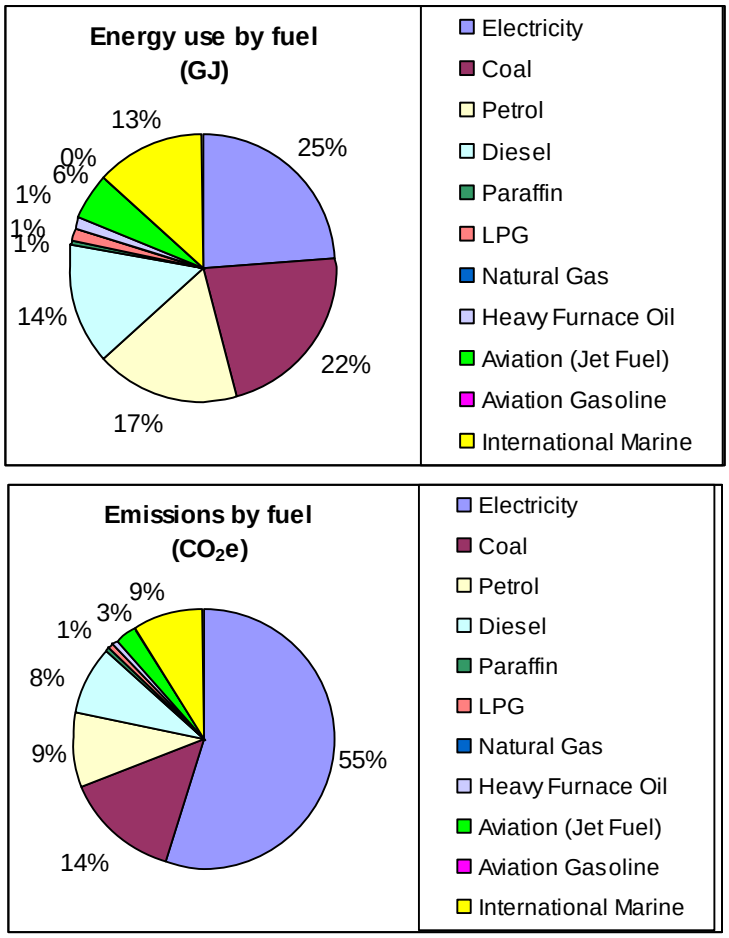


Figure 2: Energy use and energy-related emissions by fuel type in the Western Cape Province

Electricity, coal, petrol and diesel dominate the mix of fuel consumed in the province in 2009, in that order. It is interesting to see that international marine and aviation fuels contribute significantly to provincial fuel consumption (13 and 6% respectively). Until recently, with the protocols developed relating to emissions reporting, these fuels were not included in local energy studies, but were rather considered part of a national or international responsibility.

This fuel picture demonstrates the persistance of the enormous reliance on fossil-fuel in the province. Electricity is taken to be derived proportionally from the national mix, which is approximately 95% low-grade coal-fired generation, and 5% nuclear; and, apart from the nuclear and peaking stations, is brought in from the north of the country. Over 30% of the fuel is oil/coal/gas derived liquid fuels, which represents a dependence on foreign oil imports (again, taking the national mix, approximately 30% of liquid fuels in the country are locally produced from coal and gas). This obviously renders the province vulnerable to disruptions in fairly long supply lines. Direct use of coal in industrial processing contributes sizeably to the provincial energy picture.

Information from municipalities indicates that take up of solar water heater (SWH) technology and EEDSM is still in its infancy across the province. However, the City of Cape Town, which accounts for the majority of the energy consumption, is rapidly developing this area of work. This will provide important experience for the region. The only figures available for SWH uptake in the province for 2009 were a total installation figure of 98 high pressures systems and the installation of low pressure systems (ultimately 2,300, but not sure if completed by end 2009) in Kuyasa in Cape Town. No low-pressure systems were installed in 2009 through the Eskom rebate programme. By 2012 the figures through this programme for the province were 479 high pressure and 1,584 low pressure systems. This will be an important area to track. Data-collection methods need consideration.

Tracking energy consumption over time

Energy-related data for the province has been collected over the years. Given various data uncertainties, strong conclusions cannot yet be drawn, but the emerging picture, shown in the table below, indicates that energy consumption in the province has grown from 247,742 TJ in 2004 to 270,887 TJ in 2009 (excluding aviation and marine figures). The Western Cape remains at around 10% of the national consumption, with growth in energy consumption matching that of the rest of the country. The last Department of Energy Provincial Energy Balance data is recorded in the below table (these have since fallen away, but the indication is that they will return), but as it is substantially lower than the data from 2004 and 2009, it likely does not provide a reliable picture of energy consumption in the province for 2000. This provides an indication of the strides made in local level data colelction over the past 13 years.

Table 11: Tracking energy consumption over time in the Western Cape Province
NOTE: This table includes Eskom data for the Provincial breakdown

Sector	Energy (TJ)			
	% growth (2004-2009)	2009	2004 (PGWC)	2000 (DME Prov Energy balances)
Residential	8%	28,703	19 529	17 402
Commercial and public services	12%	15,659	8 872	6 156
Industrial	-1%	112,879	120 365	31 568
Transport	5%	109,027	86 382	97 753
Agriculture	-18%	4,698	12 604	13 067
Total	**6%**	**339,195**	**247 752**	**165 946**

Note that aviation and maritime fuel use was not included in the transport sector of the table above for 2009, as it had not been included in the 2004 data. This allowed for a comparison to be made between 2004 and 2009. For the same reason, the 2009 local government and commercial sectors data was combined in the above table. This has resulted in apparent discrepancies between the above table and the pie chart given below. The pie charts include aviation and maritime energy use, and commercial and local government energy use is not combined.

At this stage the data-collection methods are still in their infancy, making it risky draw conclusions from the above growth figures. For example, prior to 2009 public services may well not have been specifically measured, agriculture may be combined with commerce, etc. There does seem to be some increase in energy consumption in the built environment (residential, commercial and public sectors) and the transport sector. This would require further research.

Sector Disaggregation

A large proportion (52%) of energy consumption in the province is consumed within the transport sector; this is followed by industry at 34% (below figure). Across the province the residential/household sector is only responsible for some 9% of energy consumption. Coupled with commerce, this predominantly built environment energy consumption consumes some 13% of total energy. However, this contribution is proportionally larger when considering electricity as a fuel on its own.

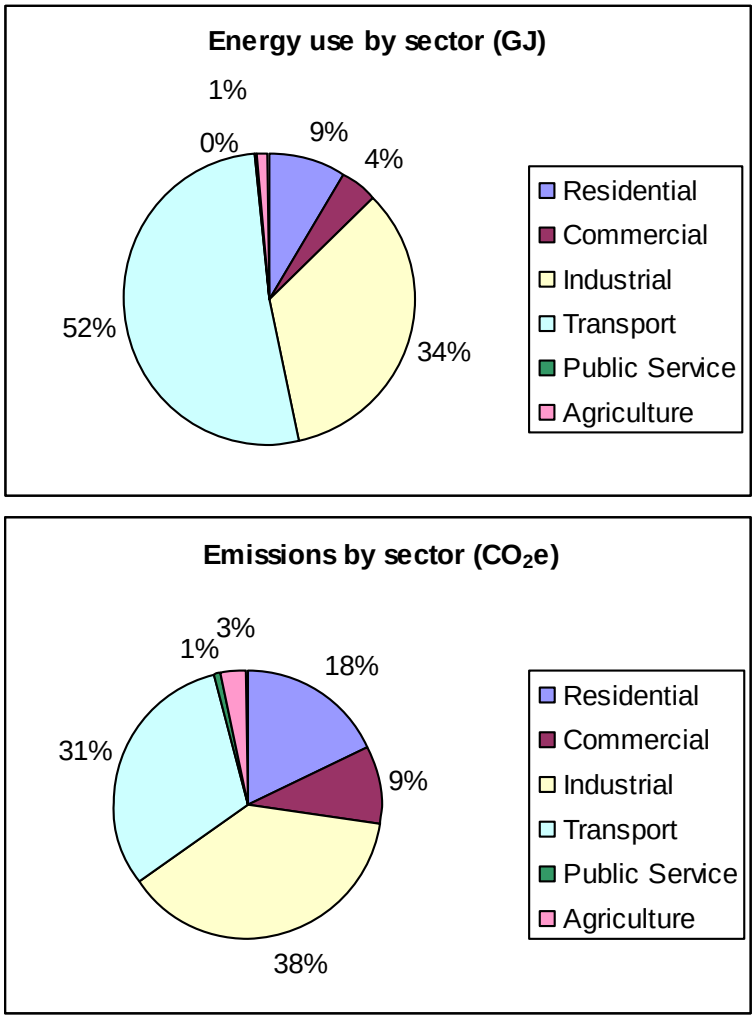


Figure 3: Energy use and energy-related emissions by sector in the Western Cape Province

It is industry, however, and not the transport sector, drawing as it does on coal-derived fuel (electricity, but also a fairly large amount of direct coal consumption), that contributes the most to provincial carbon dioxide (equivalent) emissions. As can be seen in the above figure, the built environment (comprising the residential, commerce and public sectors is a higher proportion of provincial emissions than energy totals. This is due to this sector using electricity, which has a relatively high emissions factor (relative to liquid and gas fuels).

It is worth exploring electricity consumption by sector, given that this is the single-largest fuel source in use in the Western Cape province. A disaggregation of electricity consumption shows that while industry is the largest consumer, the built environment (comprising the residential, commerce and public sector), when taken together, consumes nearly 50% of all electricity in the province. Furthermore, the residential sector in particular, contributes substantially to peak demand for electricity.

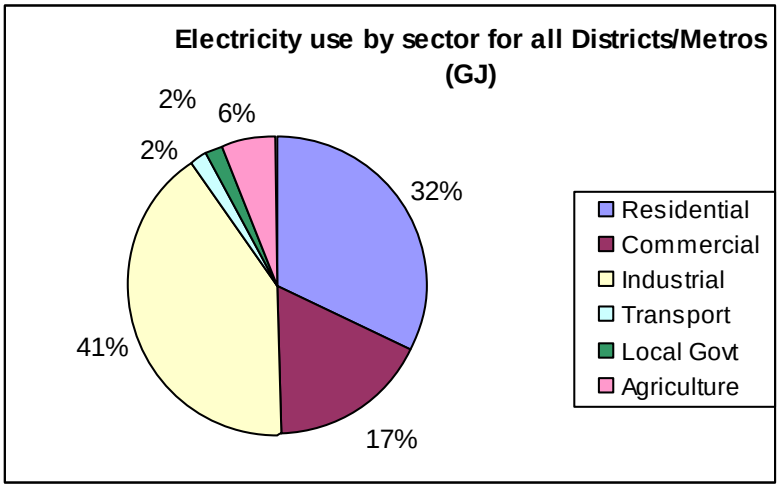
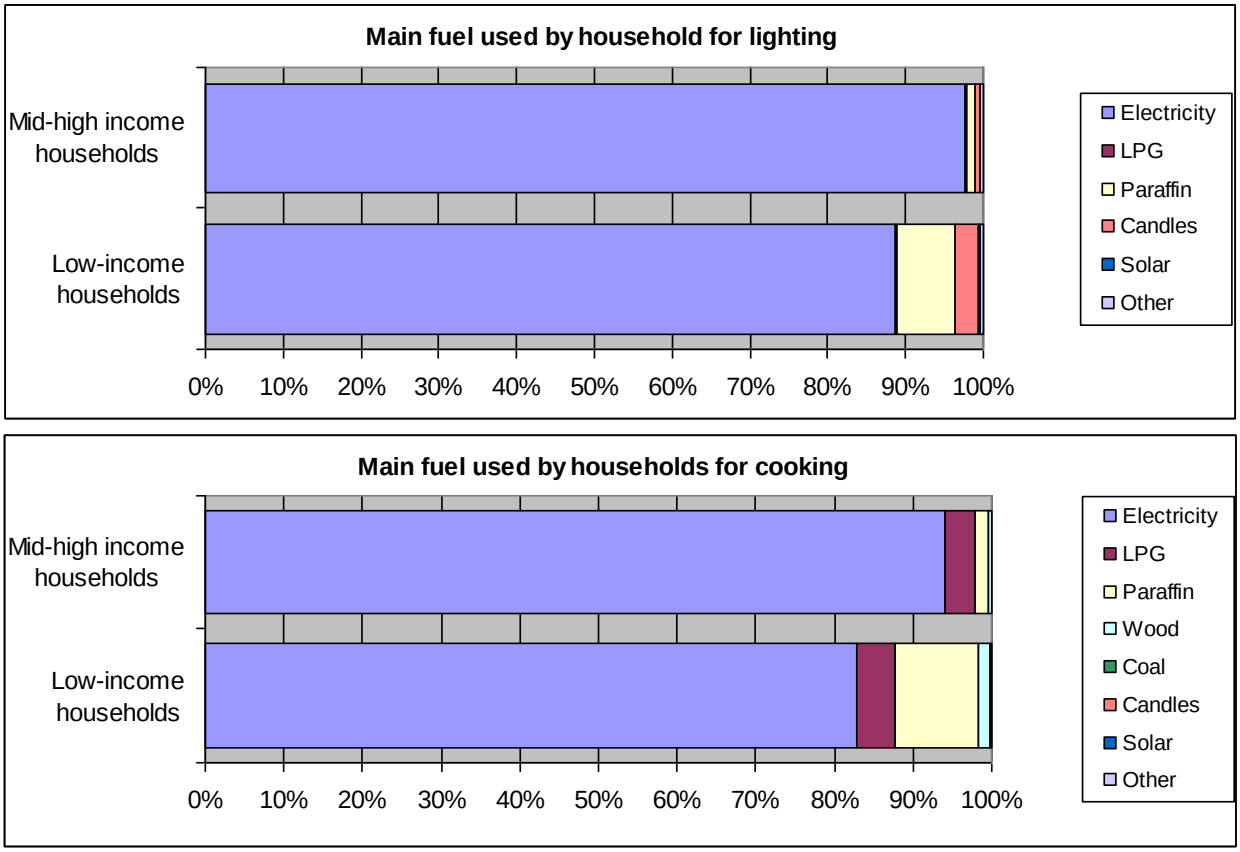


Figure 4: Electricity consumption by sector in the Western Cape Province

Residential Sector

As noted above, the residential sector does not contribute substantially to overall provincial energy consumption, but is a major sector in relation particularly to electricity consumption. When load profiles are analysed, the residential sector contributes substantially to daily peak demand, making this sector particularly important when managing energy security.



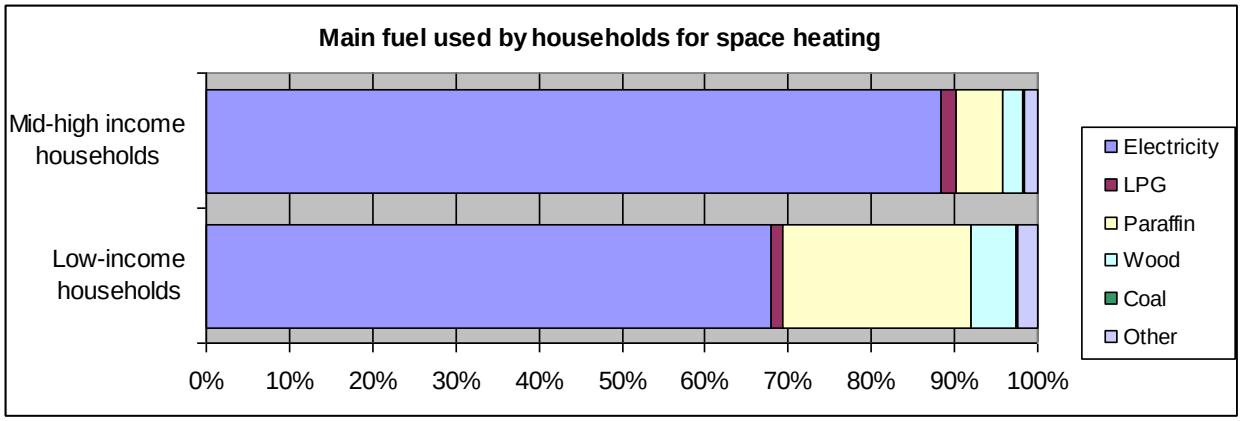


Figure 5: Fuel used by households for lighting, cooking and heating in the Western Cape

Fuel use for lighting can be used as a proxy for electrification, as an electrified household will, first and foremost, use electricity for lighting before using it for any other end-use (e.g. cooking or space heating). Provincial levels of electrification stand at around 88-89%. This is fairly high when compared to the national average of 82%. However, the data indicates that high levels of fuel mixing still occurs in low-income households in particular, with paraffin and wood being used for space heating; and gas, paraffin and small amounts of wood for cooking. This is particularly noticeable in the space heating data; showing a very large percentage of households using paraffin. This highlights the issue of energy affordability. Though a high proportion of low-income households have access to electricity, they are still mainly using it for lighting. In many households it is seen as too expensive to use for space heating and cooking. Unsafe and unhealthy fuels are fairly commonly used (over 30% of households using paraffin or wood for space heating) in poorer households, resulting in fires, accidents, burns and respiratory diseases. These can be enormously costly, to each household and the economy more broadly.

A relatively high proportion of households use LPG for cooking. The use of LPG, instead of electricity, for cooking can bring down peak electricity use, as cooking generally occurs during peak electricity use times.

Commerce and Industry

Industry accounts for 41% of the provincial energy consumption. The iron and steel industry, as well as other relatively heavy industries (cement, lime, mineral beneficiation) along the West Coast of the province contribute substantially to the provincial energy and emissions picture. These industries are very aware of the need to pursue efficiency opportunities and have already instituted substantial efficiencies.[15] However, as the province is dependent on this economic activity, which is very reliant on fuel prices and energy security, considering the future of these sectors is important. If the industry contracts or collapses due to carbon taxes and/or high energy prices, job-loss and social implications will be large.

While the heavy industries above account for most of the coal consumption in the province, coal is also used substantially in the public sector (hospitals and prisons), brickfields and boilers in manufacture (paper, textile, food).

Electricity is the most sizeable fuel used within industry and commerce. An analysis of the top electricity consumers (aside from the very large, heavy industries) across the province indicates that the following are the highest users and offer enormous opportunity in terms of improving energy efficiency:

- the retail sector, such as malls and shopping centres
- the public sector – army, police, hospitals, government offices, local government services and parastatals
- manufacture – agri-industrial, food, textile and paper
- fast food outlets
- abattoirs

[15] Sources: 1) Personal communication with Managing Director of Namakwa Sands; 2) Arcelor Mittal Annual Reports on Saldanha Steel.

Efficiency opportunities in commerce predominantly relate to those of the built environment: efficient HVAC (heating, ventilation and cooling), water heating, lighting and building orientation and construction. Behaviour campaigns around the use of energy in buildings are also effective. The predominance of the public sector within this sector offers enormous potential for the Western Cape Government to support effective uptake of efficiencies.

Transport

Given the lack of detailed transport data, there is no modal split for the province at this stage. This could be worked on through establishing estimated passenger kilometres and relating this to fuel consumption. However, with the lack of data on the transport characterisation of towns along national roads, small towns versus larger metros, etc, this was felt to be premature.

Data has been gathered on the number of vehicles per capita and the number of private vs. public vehicles. These two indicators can be tracked over time.

Table 12: Number of private vs. public vehicles and vehicles per capita per municipal district

Vehicle Type	Cape Winelands	Central Karoo	Eden	Overberg	West Coast	Cape Town
Public	3 953	198	3 125	1 273	1 596	28 943
Private	105 044	5 569	101 226	41 321	48 756	787 434
Other	12 134	462	7 709	5 411	9 785	14 800
Freight	63 072	4 848	59 463	28 373	40 863	247 712
Vehicles per capita (2011)	**0.24**	**0.22**	**0.31**	**0.36**	**0.36**	**0.27**

The StatsSA Household Surveys indicate that mode of transport is strongly correlated to income category, with mode shifting from walking/public transport to own transport as income rises. The majority of people in South Africa are in the lower income bands and this makes non-motorised transport (NMT) and public transport an important mode of transport to invest in both nationally and provincially. Given the contribution of transport fuel to the provincial energy and emissions mix, working to address this sector would be important.

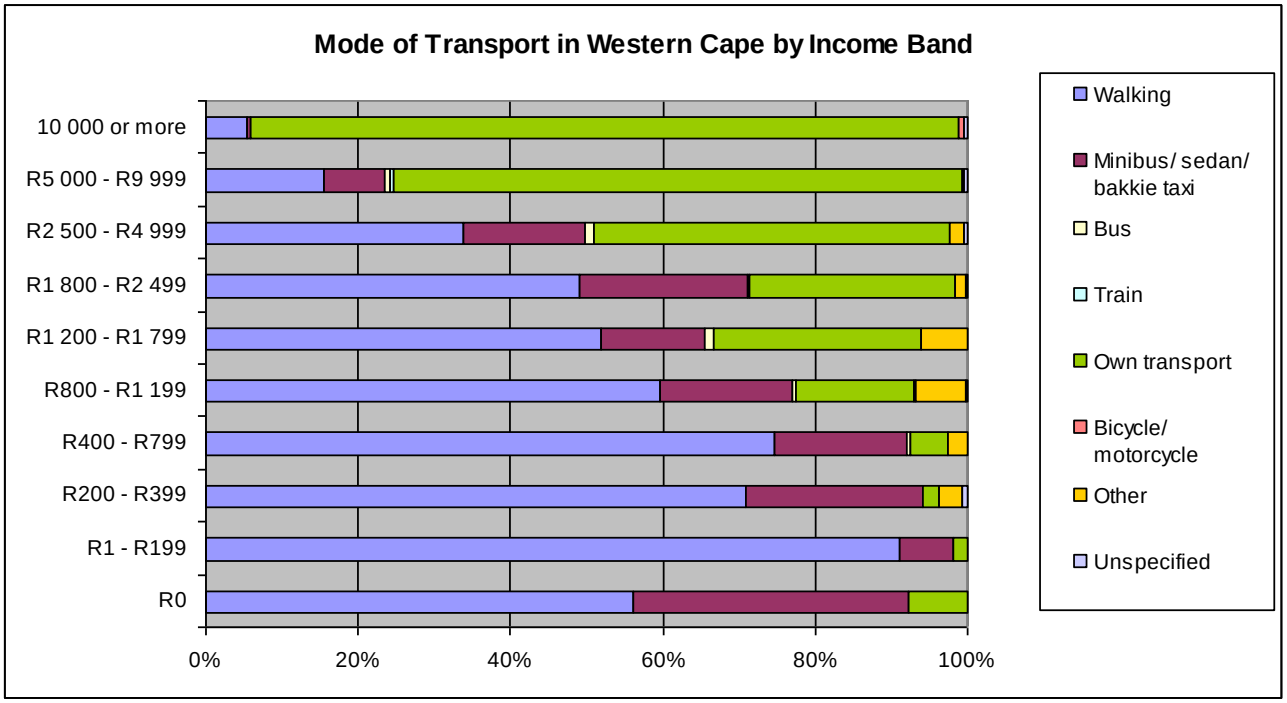


Figure 6: Means of transport to work and school by income group in the Western Cape[16]

Local Government and Public Sector

Local government accounts for some 2% of energy consumption in the province. Local government are not only big energy users and significant distributers of electricity, but are also ideally placed to influence the energy use of others, as they are major employers and the primary planners and service providers in the municipality. Energy cost is a variable cost, which can be controlled by cutting down on wasteful energy consumption – greater energy efficiency means lower financial costs and improved competiveness. In the case of local government, cost savings through improved efficiencies can be used for improved service delivery.

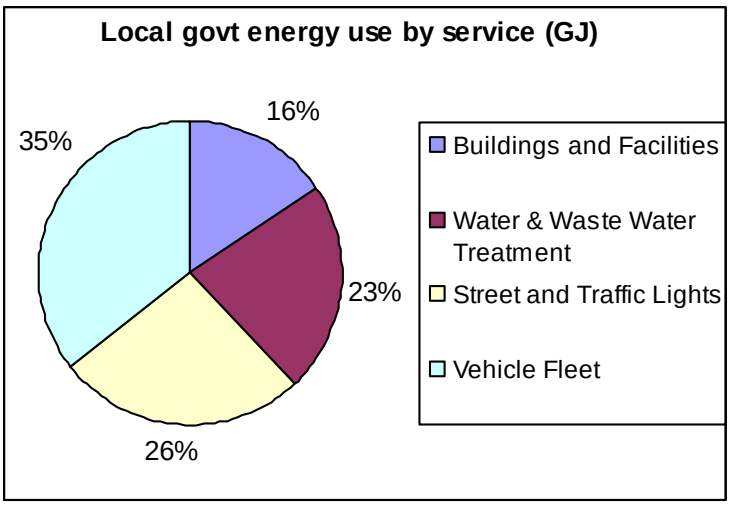


Figure 7: Local government energy use in the Western Cape Province

Vehicle fleets, as the largest consumer of energy in local government in the province, offer enormous opportunities for energy efficiency improvements. This can be achieved through management programmes and improved procurement requirements, e.g. fleet greening and improved efficiency initiatives. Efficient street lighting programmes can be quickly implemented; again, building efficiency into procurement requirements offers an important avenue for ongoing implementation of sustainable technologies. The Integrated Demand Management (IDM) programme of Eskom may be important in terms of funding initial retrofits across the province. Buildings and facilities can also be made more efficient, largely through lighting and HVAC retrofits, occupancy sensor technologies and behaviour campaigns. This can sometimes be fairly complex in terms of implementation procedures, and Province may consider how to develop a programme in support of these activities.

To do this, human capacity within the municipalities is required to drive the projects. While many of the municipalities are relatively well-resourced in terms of electricity department staff, the Karoo municipalities, and some within Eden (notably Kannaland), stand out as not having even the minimal capacity. Where capacity is lacking this is a critical gap to fill; where it exists, this is a valuable resource to build and develop towards the sustainable energy and climate response goals of Province. The enormous wealth of experience in the City of Cape Town – both organisationally/institutionally and in relation to implementation, also provides a wealth of capacity that the Province can capitalise on. See Appendix 4 on municipal sustainable energy development capacity.

Conclusion

This report provides an overview of energy and energy related emissions in the Western Cape Province. It is not a strategy report, although it raises key areas of concern or potential with regard to the sustainable energy objectives of the province, as they may have arisen.

[16] StatsSA General Household Survey 2009

The exercise of tracking energy and related emissions consumption over time is beginning to bear fruit. The Western Cape now has reasonably developed data for the years 2004 and 2009. This begins to deepen the knowledge around data sources and data methodologies and increase the confidence in the data picture arising.

Key Issues

- Despite the high level of electrification, a large percentage of households are still using a mix of energy fuel (paraffin, wood, etc) for cooking and space heating, indicating energy poverty, i.e. energy such as electricity may be available, but not affordable.
- The Western Cape Province's energy consumption is dominated by the metro and heavy industry on the West Coast.
- The metro has a high sustainable energy staff capacity when compared to other districts and has undertaken pioneering work where energy efficiency and renewable energy is concerned. The metro can act as a hub of information for other similar actions in other districts and local municipalities.
- The industrial sector is a large consumer of energy. Indications are that these industries are already pursuing energy efficiency measures. This could be explored further. The economy and job creation would be sensitive to large increases in electricity prices, carbon pricing, water shortages, etc.
- The built environment (residential and commercial sectors) is a large consumer of electricity, which is the fuel that proportionally accounts for the highest amount of GHG emissions. Building efficiency is important for decreasing electricity use in this sector. It is also a high national priority (flagship programme identified with the National Climate Change Response White Paper).
- Fuel consumption from national roads, aviation and maritime contribute to large amount of an area's energy use where these occur, but are not within the energy management jurisdiction of these areas.
- Institutional capacity to deal with sustainable energy issues ranges across a wide spectrum, with the larger metros/municipalities generally having the highest capacity. Smaller municipalities may require considerable support in implementing sustainable energy programmes and projects. However, there is also concern as to the absence of new engineers in electricity departments. This would need to be addressed.
- This study focuses on energy consumption. However, the Western Cape Province is the area identified for potential new energy supply source, e.g. natural gas and new nuclear. The Western Cape Government needs to position itself to engage with these initiatives.
- Local Municipalities' own energy consumption always offers a relatively easy entry-point into energy management. Issues to address would be management of electricity losses, energy use in the built environment and water pump stations.
- While there are some challenges to access data, the one area that is completely absent is the systematic collection of information on sustainable energy interventions implemented. Some thought needs to be given as to how local government will record sustainable energy initiatives.

ENERGY DATA OVERVIEW: CAPE TOWN

Introduction

The City of Cape Town is the second largest city in South Africa after Johannesburg and the only metropolitan municipality within the Western Cape Province. The current population of Cape Town is estimated at 3,497,097 people making it the most populous place in the province. The city covers an area of 2,460 km^2, translating to a density of 1,422 people per square kilometre.

Cape Town has the second largest economy and contribution to the South African economic output. The Cape Town economy is progressively shifting towards the services industries, with the largest areas of growth being finance, business services (35% of economic activity), manufacture (15%), trade, catering, accommodation, tourism (15%), transport and communication (10%). General government accounts for 10% of economic activity and construction activity 4% (CCT IDP, 2009).

The informal economy in Cape Town is involved in activities – mainly wholesale and retail trade, home-based catering and accommodation, and working in private households - that are not linked into the city's main economic activities.

The report provides a brief energy picture for the City of Cape Town. It is noted that the City has a number of detailed Energy and Climate Change related policies and strategies, and this is therefore a rather simple synopsis of the 2009 data picture.

The energy picture

Table 13: Key sustainable energy indicators in Cape Town

Key sustainable energy indicator	Unit of measure	Metro Value 2009	Provincial Value 2009	Cape Town as % Province	National Value*
Energy consumption per capita	GJ/capita	56	64	-	53
GHG emissions per capita	tCO_2e/capita	7.0	8.0	-	7.7
Energy per GDP (R' mill)	GJ/GDP	1,074	1,428	-	1, 094
GHG emissions per GDP (R' mill)	tCO_2e/GDP	134	178	-	159

* Source: Department of Energy: South African Energy Synopsis 2010: data for 2006 only/SA's 2nd National Communication, 2011, data for 2000 only

The energy consumption and related GHG emissions taking place within the Cape Town area accounts for well over half of the provincial totals. It is an extremely intense energy node in the province. However, per capita emissions are just below the national and provincial averages. This is likely due to the economy being increasingly service sector related – with relatively lower energy intensities than that associated with heavy industry and even manufacture. There is also a high concentration of very poor people living within the metro, with very low levels of energy consumption, contributing little to the overall energy consumption.

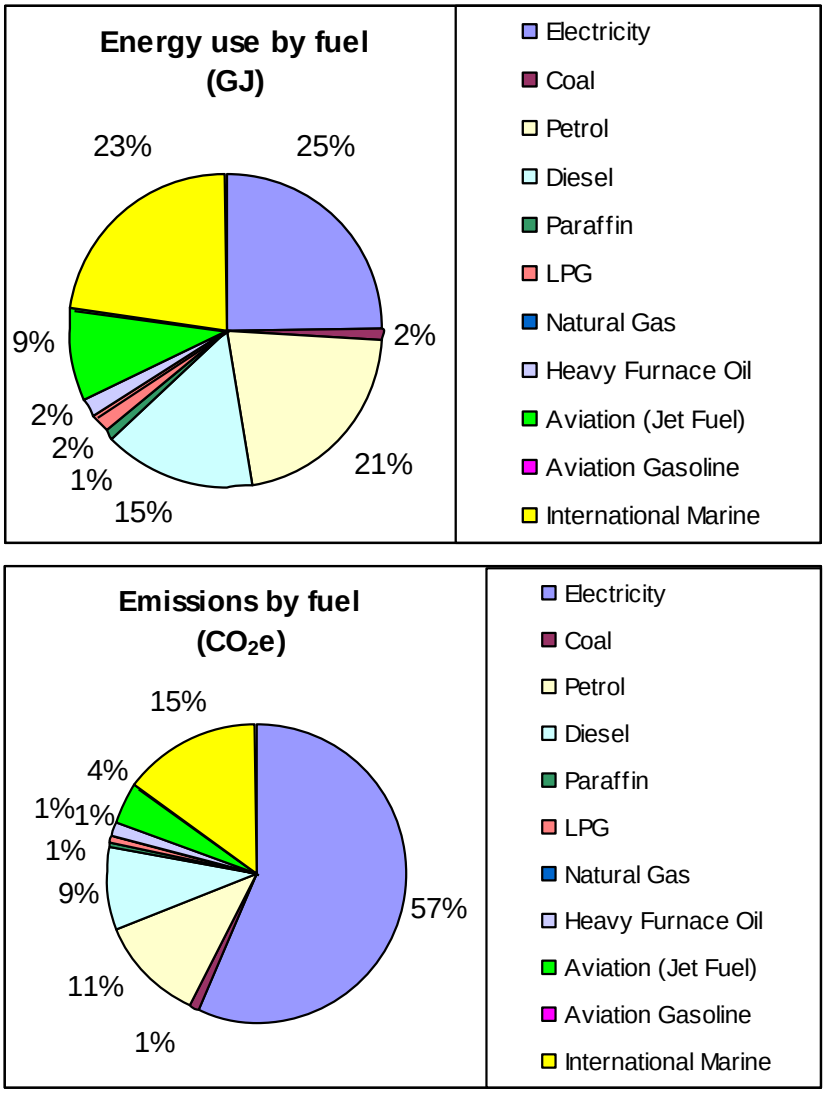


Figure 8: Energy use and energy-related emissions by fuel type in Cape Town

Electricity is the largest fuel consumed (25%), followed by International marine related fuels (23%), petrol and diesel (21% and 15% respectively). Aviation fuel also has a substantial impact on the overall picture, at 9% of total consumption. The inclusion of aviation and international marine fuels has emerged out of GHG emissions protocols, and slightly skews the picture as these are really national and international areas of responsibility. The effect of the exclusion of aviation and maritime fuels is shown in the figure below.

Despite this heavy liquid fuel dominance (in combination amounting to over 60% of total), electricity consumption is the largest source of carbon emissions (57%) within the city, deriving as it does from coal (with 5% nuclear) based Eskom generation. Diesel and petrol use contributes 9% and 11% of emissions, respectively and International Marine 15%.

The City's energy picture is clearly dominated by fossil fuels; these fuels might be relatively cheap and convenient, however they carry environmental risks such as local air pollution and a contribution to global emissions that are driving global climate change. Economic vulnerability is another risk the city carries from its dependency on fossil fuels due to supply chain disruptions such as war or sanctions as well as economic costs associated with a global carbon pricing regime.

Well aware of the risks, and responsibilities in a world seeking to mitigate the run-away effects of severe climate change, the City has embarked on institutional (policy, organisational) changes and programmes towards meeting sustainable energy and climate responsive targets that closely align with those of the Province. This work was in its early days in 2009, with the Kuyasa Clean Development Mechanism project (solar water heating, efficient lighting and ceiling retrofits in low income households) under development. This project, since 2008, contributes approximately 7.4 million kWh in savings. In 2009 Cape Town was given monies within the national Municipal Energy Efficiency and Demand Side Management (EEDSM) Programme (managed by the national Department of Energy) and began an extensive programme of efficient public lighting retrofits. Savings from this programme began contributing to local 'energy mix' from the end of 2009.

For interest, graphs excluding maritime and aviation fuels have been included below.

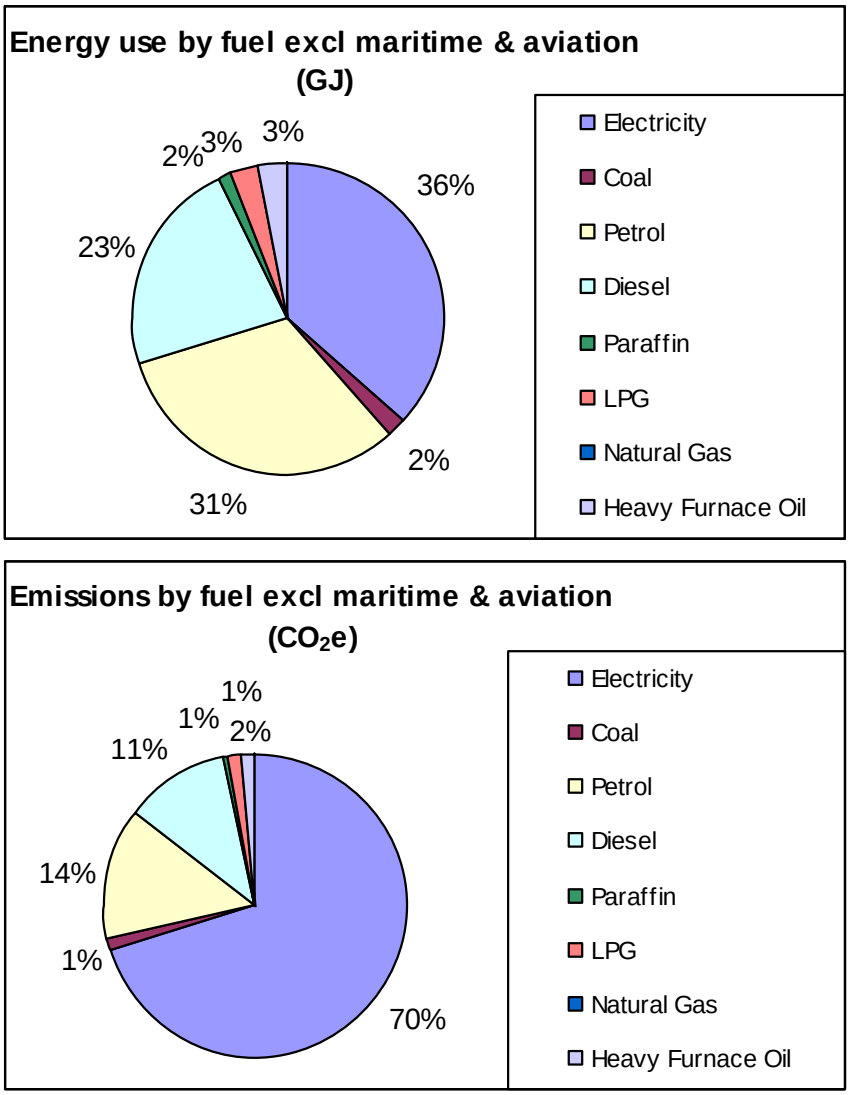


Figure 9: Energy use and energy-related emissions by fuel type in Cape Town excluding maritime and aviation fuels

Tracking energy and emissions over time

The City of Cape Town pioneered local energy data collection and collation and has data going back to 2003. Table 2 below provides insight into the energy and emissions related profile of the City of Cape Town since 2003 (note that emissions conversion factors used in this study are fuel and country specific, old emission factors were generic GJ-CO_2e values).

Table 14: Energy and energy-related CO_2e Emissions Comparison in Cape Town (2003-2009)

	2003		2007		2009		
	GJ	CO_2e	GJ	CO_2e	GJ	CO_2e old conversion factors	CO_2e new conversion factors
Electricity	38 835 284	11 256 863	48 576 102	14 844 856	48 303 379	14 761 513	12 852 578
Coal	3 831 352	361 680	3 055 991	288 485	3 055 991	288 486	277 011
Petrol	40 687 369	2 815 566	39 392 694	2 725 974	41 620 196	2 880 118	2 787 329
Diesel	20 127 757	1 487 441	27 874 053	2 059 892	30 064 496	2 221 766	2 308 944
Paraffin	2 448 796	175 579	2 830 399	202 939	2 034 767	145 893	145 617
LPG	684 970	43 153	1 750 168	110 260	3 748 138	236 133	132 756
Heavy Furnace Oil	4 695 842	362 519	4 116 143	317 766	3 967 139	306 263	293 522
Subtotal (excl aviation and marine)	110 231 787	16 502 801	127 645 128	20 550 175	132 794 105	20 840 171	18 797 757
Aviation (Jet Fuel)	-	-	16 082 323	1 153 103	18 338 382	1 320 364	1 063 279
Aviation Gasoline	-	-	-	-	46 892	3 376	2 316
International Marine	-	-	38 237 320	2 990 158	44 815 082	3 495 576	3 705 723
Total	-	-	181 964 771	27 358 547	195 994 461	25 659 487	23 575 074

Source: Cape Town 2011: State of Energy and Energy Futures Report, and current study

The indication is that energy consumption (excluding the marine and aviation figures) increased by approximately 4 million GJ per year between 2003 and 2007 and then an average of 2.5 million GJ/year between 2007 and 2009. These are clearly far from definitive indications of trends, but are worth greater exploration (establishing economic and population growths over these periods, etc) and begin to show the value of data collection over time.

Sector Disaggregation

Cape Town's energy picture below is dominated by the transport sector, which consumes approximately 71% of all energy in the metro, followed by the industrial (13%), residential (11%), commercial (5%) and lastly local government at <1%. In terms of GHG emissions per sector the transport sector accounts for 42% of the total emissions in the city followed by the residential and industrial sectors that account for 22% and 24% respectively. It is interesting to note that although the transport sector consumes 71% of Cape Town's energy it only contributes 42% of the total emissions. When commerce and residential sectors are combined this 'built environment' consumption accounts for some 32% of total emissions (16% of consumption).

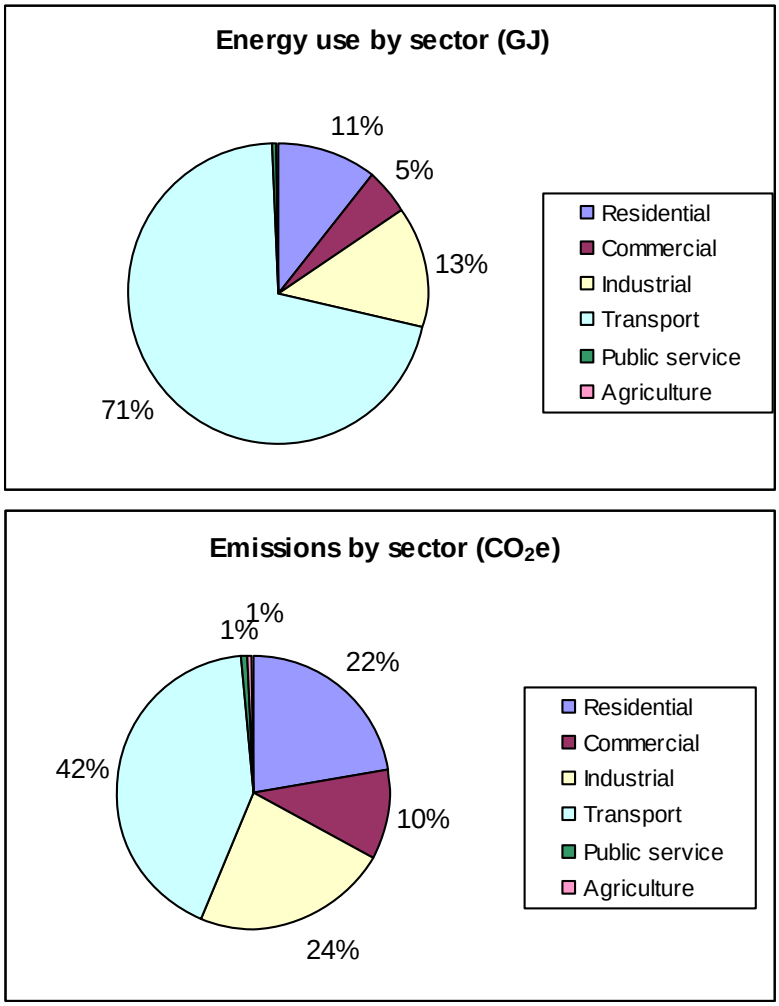
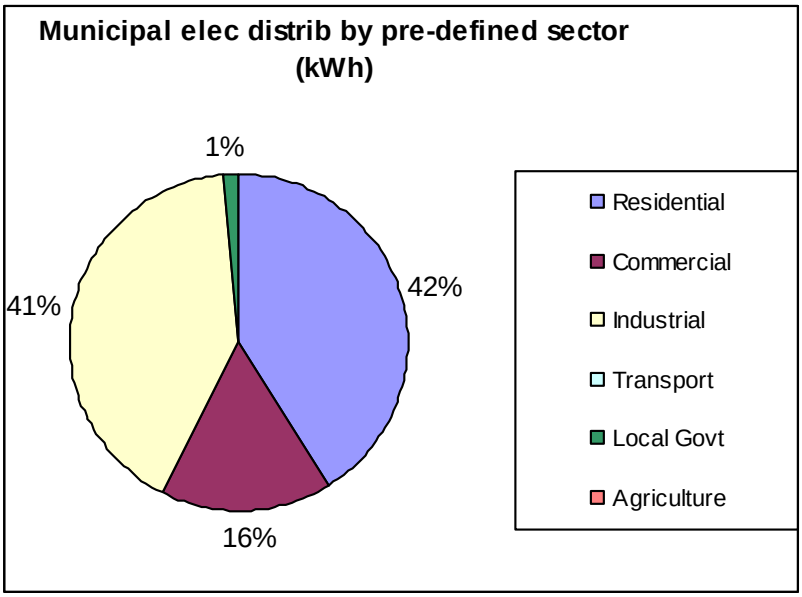


Figure 10: Energy use and energy-related emissions by sector in Cape Town

As the single largest fuel source, it is worth disaggregating the electricity consumption across the metro. The below figure shows distribution of electricity by sector (total electricity) and by Municipal tariff (municipal distribution areas only). The first pie chart shows that industry and the residential are the major, 'twin' consumers of electricity. The residential sector is important for various reasons: it largely drives peak demand, but also contributes fairly substantially to municipal electricity revenues. Managing efficiencies and clean energy 'switching' in this sector can be complex. Work being undertaken by the City and partners in this area will be important for developing sustainable and financially viable, developmental approaches in smaller municipalities.



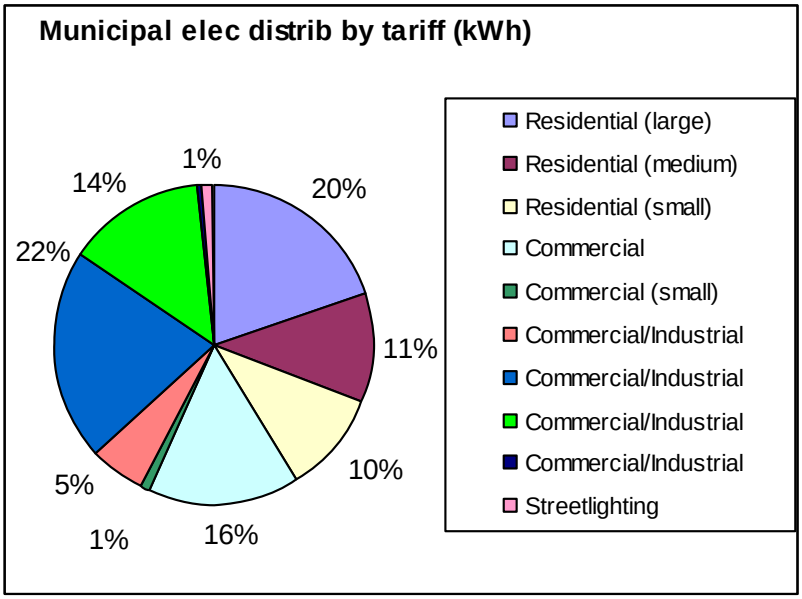


Figure 11: Electricity use by sector in Cape Town (does not include Eskom distribution)

For interest, graphs excluding maritime and aviation fuel are shown below.

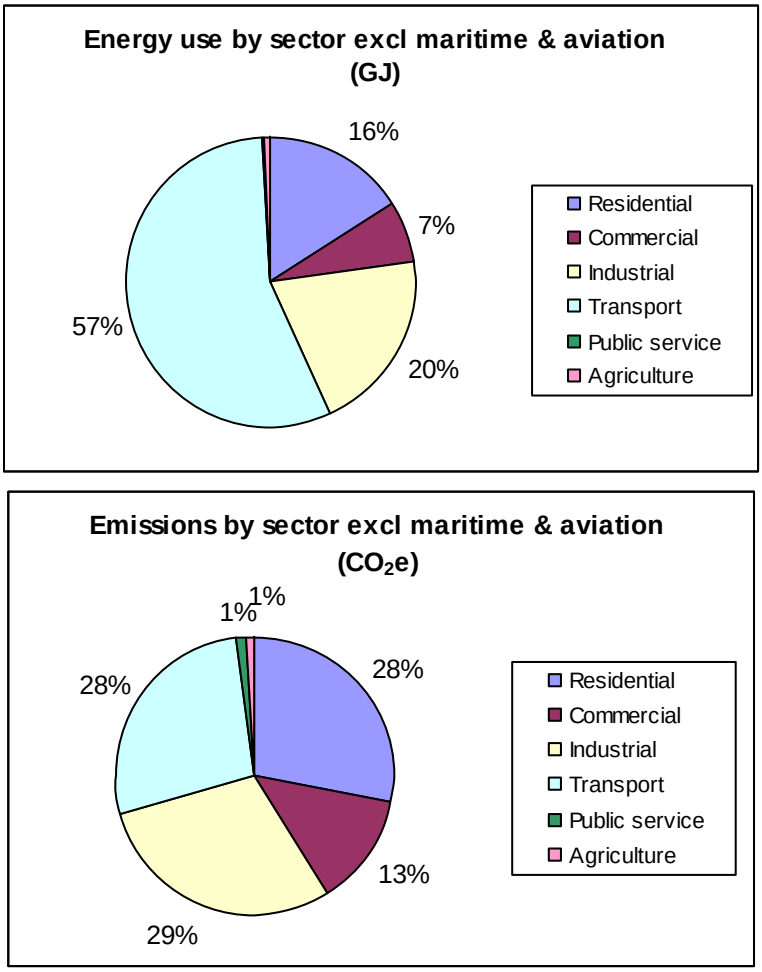


Figure 12: Energy use and energy-related emissions per sector in Cape Town excluding maritime and aviation fuels

Residential Sector

Electricity is the dominant energy carrier used by households for lighting, cooking and space heating purposes in both the mid-high and low income households.

Table 15: Household electricity consumption in Cape Town (City of Cape Town supply only)

Residential category	Ave monthly consumption (kWh)	Number of customers	Total kWh/month	% Total customers	% Total consumption
Low consumer	220	382,889	84,235,580	43%	19%
Medium consumer	520	284,989	148,194,280	32%	34%
High consumer	930	182,115	169,366,950	21%	39%
Very high consumer	1,033	35,068	36,225,244	4%	8%
Total	**-**	**885,061**	**438,022,054**	**-**	**-**

The figures indicate that nearly half of the residential customers consume only 20% of total residential consumption; while 25% of customers consume nearly half of all consumption (45%).

Use of electricity for lighting is often used as a proxy for household electrification. By this reckoning some 88% of Cape Town households have been electrified. This is strong against a national average of 82%. The figures for electrification backlog stand at:

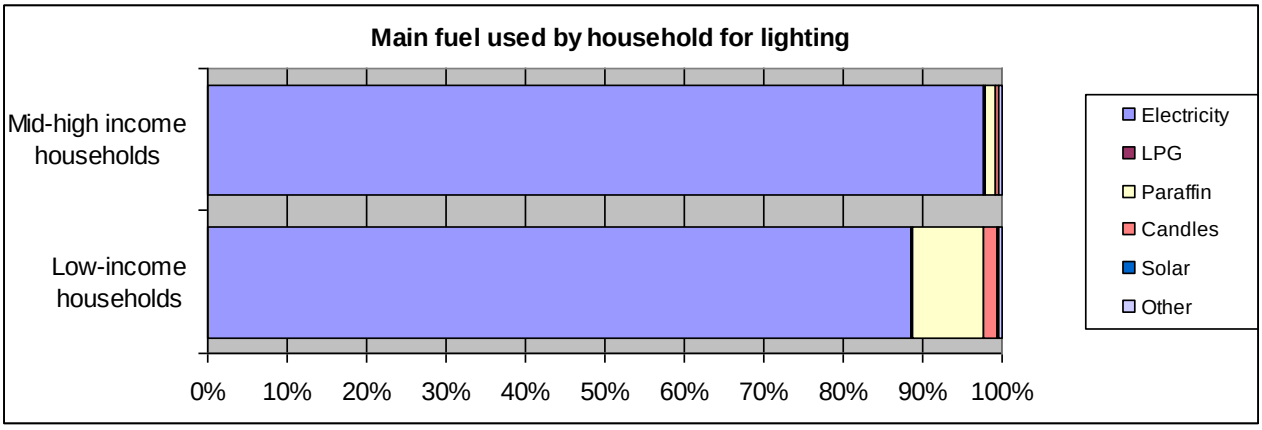
Table 16: Electrification backlog in Cape Town

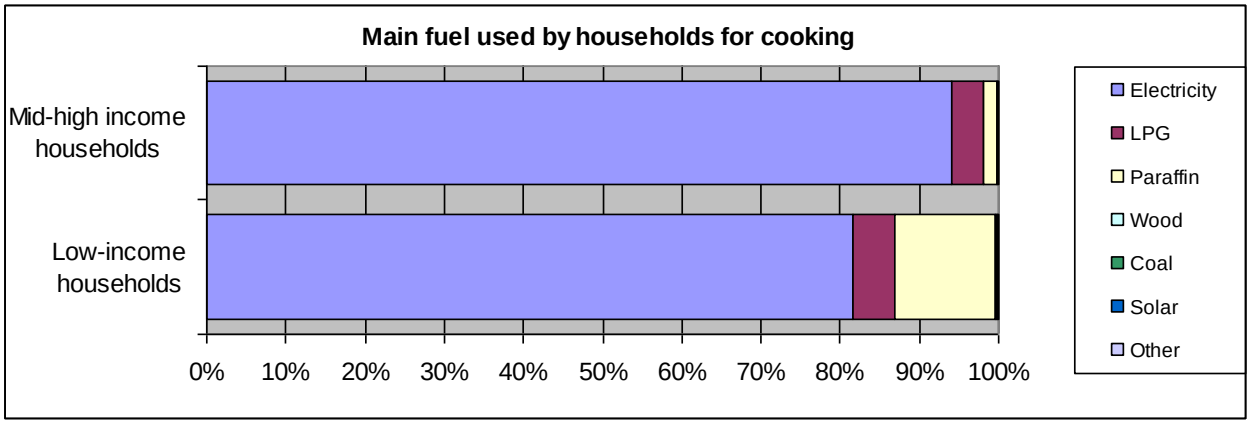
Electrification Backlog	Household
Without growth	46 045
With 2% household growth	128 404

Source: National Department of Energy, 2009

Within the City a total of 270,660 households qualify for the Free Basic Electricity grant (SEA Municipal Questionnaire, 2012). Qualification is based on consumption levels (households with a monthly average below 400kWh qualify for the subsidy). It would be useful to track the proportion of households qualifying for an electricity subsidy over the total number of households, over time. This would provide some idea of whether this is growing relative to total consumption.

While electricity is the main source of energy for lighting, cooking and space heating in households across all income groups, a significant amount of paraffin is used for all of these activities amongst low income households. This represents a severe risk in terms of household fires, burns, accidents, poisoning and respiratory illness. Cape Town is known for its run-away fires during the dry, windy season and it is anticipated that the conditions of climate change will exacerbate these conditions. When a family, or community, lose their entire household assets this has an enormous economic, social and psychological impact.





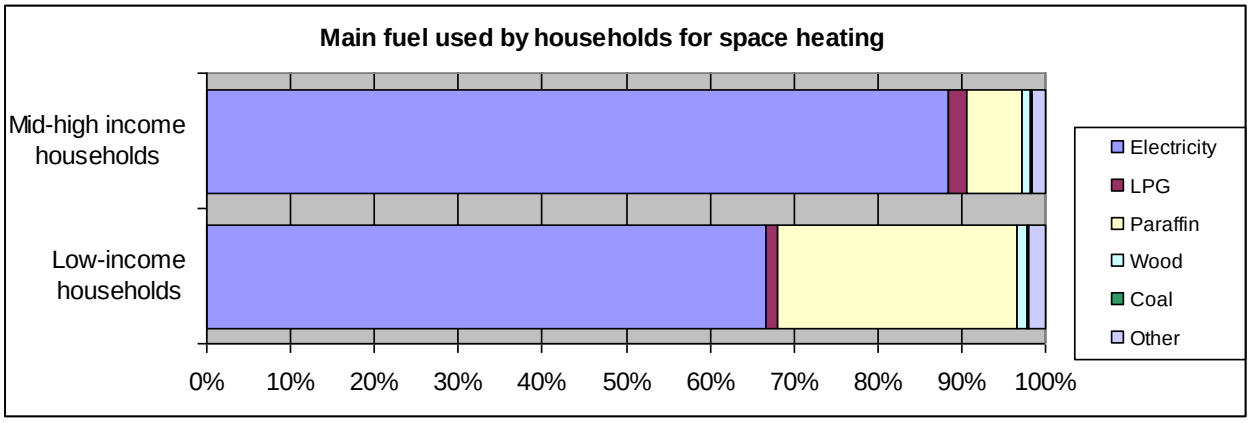


Figure 13: Fuel used by households for lighting, cooking and heating in Cape Town

In Cape Town there also seems to be a significant use of liquefied petroleum gas (LPG) for cooking, in particular, throughout the different income group households.

Commerce and Industry

Primary coal consumption accounts for only 2% of energy and 1% of city GHG emissions. The largest consuming sector is the public sector – notably hospitals, followed by manufacturing, with paper, textiles and food being the largest areas of coal consumption. Cape Town also has a brickfield which is a fairly high coal consumer.

The commercial sector accounts for 16% (2% more than the industrial sector) of the metro's energy consumption, of which 95.6% is consumed as electricity. This sector contributes 28% of the total carbon emissions in the metro. The commercial sector includes retail and office buildings, tourism activities, education facilities, hospitals and other non-industrial activities. While electricity is the main source of energy fuelling the commercial sector, other fuels such as diesel, wood, coal, paraffin, heavy furnace oil and LPG.

Transport

City of Cape Town's recent State of Energy and Energy Future's Report 2011 points to a 50/50 private/public modal split in terms of passenger-kilometres. Data has been gathered on vehicle ownership and the growth of this can be tracked over time.

Table 17: Vehicle population in Cape Town

Vehicle type	Cape Winelands	Central Karoo	Eden	Overberg	West Coast	Cape Town
Public	3 953	198	3 125	1 273	1 596	28 943
Private	105 044	5 569	101 226	41 321	48 756	787 434
Other	12 134	462	7 709	5 411	9 785	14 800
Freight	63 072	4 848	59 463	28 373	40 863	247 712
Vehicles per capita (2011)	**0.24**	**0.22**	**0.31**	**0.36**	**0.36**	**0.27**

The poorest households live on the outskirts of the city and furthest away from potential employment opportunities, and are least able to afford the costs of urban sprawl. Most often, poorer residents have to commute longer distances and times using public transport modes that are currently not optimally integrated.

Local Government

In delivering its services, the municipality accounts for 1% of the total carbon emissions in the metro. This is allocated across the following sectors:

Table 18: Local government energy use by service in Cape Town

Local government energy use by service	GJ
Buildings & Facilities	149 057
Water & Waste Water Treatment	293 940
Street and Traffic Lights	366 707
Vehicle Fleet	572 386

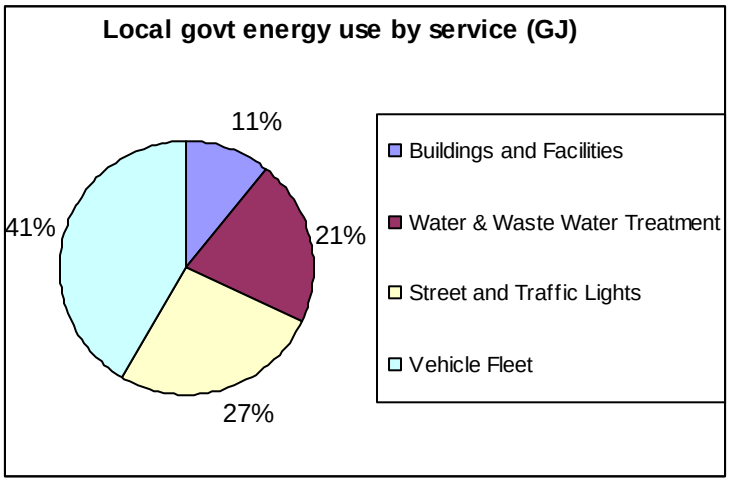


Figure 14: Local government energy use by service sector in Cape Town

The main energy sources for the City of Cape Town's municipal operations is electricity (59%) used in buildings and facilities, water and wastewater treatment, street and traffic lighting. Liquid fuels (i.e. diesel and petrol) are also a big source of energy used in the municipality's vehicle fleet. Opportunities to improve energy efficiency exist throughout the diverse range of operations the municipality has operational control. Already substantial work has been undertaken in vehicle fleet efficiency and public building efficient technology retrofits and behaviour change.

Waste figures are not very clear at this stage. The average waste per capita in the City for 2009 was 0.36 tonnes per annum. Waste contributes significantly to global warming emissions and managing this sector to reduce these is a very important response in mitigating climate change. Cape Town has conducted feasibility studies on methane flaring and/or co-generation potential of its waste and waste water sites.

The City has approximately 2 000 full time staff in its electricity distribution department. In the Energy and Climate Change units within the Environmental Management department the City has 4 full time and 5 part time staff. Sustainable transport is carried by 2 full time staff and 2 interns within the Transport department. The City has pioneered local level energy and climate response management and has a range of related policies and strategies in support of this, right up into IDP priority areas. This work as resulted in the creation of new city decision making structures and fora, new city posts and performance management criteria.

Conclusion

The Province can benefit enormously from the ground-breaking work and experience built up at the City. This is the largest energy-consuming bloc and any major uptake of provincial strategy goals relating to sustainable energy will require City support and leadership.

Key Issues

- Despite the high level of electrification, a large percentage of households are still using a mix of energy fuel (paraffin, wood, etc) for cooking and space heating, indicating energy poverty, i.e. energy such as electricity may be available, but not affordable.
- The metro is the biggest energy consumer in the Western Cape Province. Any large shifts in the provincial energy balance will take place in the metro.
- The metro has a high sustainable energy staff capacity when compared to other districts and has undertaken pioneering work where energy efficiency and renewable energy is concerned. The metro can act as a hub of information for other similar actions in other districts and local municipalities.
- The industrial sector is the second-largest consumer of energy. Indications are that these industries are already pursuing energy efficiency measures. This could be explored further. The economy and job creation would be sensitive to large increases in electricity prices, carbon pricing, water shortages, etc.
- The built environment (residential and commercial sectors) is a large consumer of electricity, which is the fuel that proportionally accounts for the highest amount of GHG emissions. Building efficiency is important for decreasing electricity use in this sector. It is also a high national priority (flagship programme identified with the National Climate Change Response White Paper).
- Aviation and maritime fuel consumption contributes to large amount of an area's energy use where these occur, but are not within the energy management jurisdiction of these areas.
- While this report gives a short overview of key issues, the City itself already has detailed strategies and business plans for sustainable energy implementation.

ENERGY DATA OVERVIEW: CAPE WINELANDS

Introduction

The Cape Winelands District, comprising 5 local municipalities: Breede Valley, Drakenstein, Langeberg, Stellenbosch and Witzenberg, is the most populous district outside the Cape Town metro in the Western Cape consisting of 707,154 people and 13.2% Western Cape's total population. The District covers an area of 22,309km^2, translating into a population density of 32.4 people per square kilometre (Cape Winelands District IDP 2012/13-2016/17).

The Cape Winelands is a renowned wine-producing and exporting region. Major economic activities taking place in this region include: 1) tourism, taking advantage of Route 62, which traverses the district, along with hiking trails; 2) agriculture contributing 7.9% to employment and 15.2% to regional GDP; 3) manufacturing, employing 14.6% of the workforce and 4) community, personal and social service supporting 13.8% employment (Cape Winelands District IDP 2012/13-2016/17).

In terms of the level of development, close to a third of all households in the district are indigent (42,333 out of 133,786 households), 55.6% of which are located within municipalities of Drakenstein (10,854 households) and Stellenbosch (12,690 households). Further, the Gini coefficient, a measure of income inequality (with 0 being a case of perfect equality where all households earn an equal income and 1 being where one household earns all the income and other households earn nothing), remains high at 0.59 in 2010. The Human Development Index (measured on a scale of 0 to 1, with one being the best), which is a measure of life expectancy, literacy and income, measures in at 0.65, revealing a moderate level of human development. Unemployment reduced from 22.4% in 2001 to 16.2% in 2007 (Regional Development Profile – Cape Winelands District 2011).

In terms of housing provision, the district accounts for the 3rd-largest proportion of informal dwellings at 10.5% relative to other districts of the Western Cape, while 82.5% households reside in formal dwellings. With regard to energy service provision, 93.6% of all households have access to electricity.

The energy picture

Table 19: Key sustainable energy indicators in Cape Winelands

Key sustainable energy indicator	Unit of measure	District Value 2009	Provincial Value 2009	National Value*
Energy consumption per capita	GJ/capita	34	64	53
GHG emissions per capita	tCO_2e/capita	5.4	8.0	7.7
Energy per GDP (R' mill)	GJ/GDP	1,143	1,428	1, 094
GHG emissions per GDP (R' mill)	tCO_2e/GDP	179	178	159

* Source: Department of Energy: South African Energy Synopsis 2010: data for 2006 only/SA's 2nd National Communication, 2011, data for 2000 only

The Cape Winelands district accounts for 7% of the provincial energy consumption total; and 8% of GHG emissions. As a predominantly agricultural (wine producing) area, with a couple of larger towns, the Cape Winelands has a lower energy consumption, and related GHG emissions, per capita than the provincial and national average. In terms of energy intensity (the amount of energy to produce a unit of economic value) it is on a par with the national average, although it remains slightly lower than the provincial average.

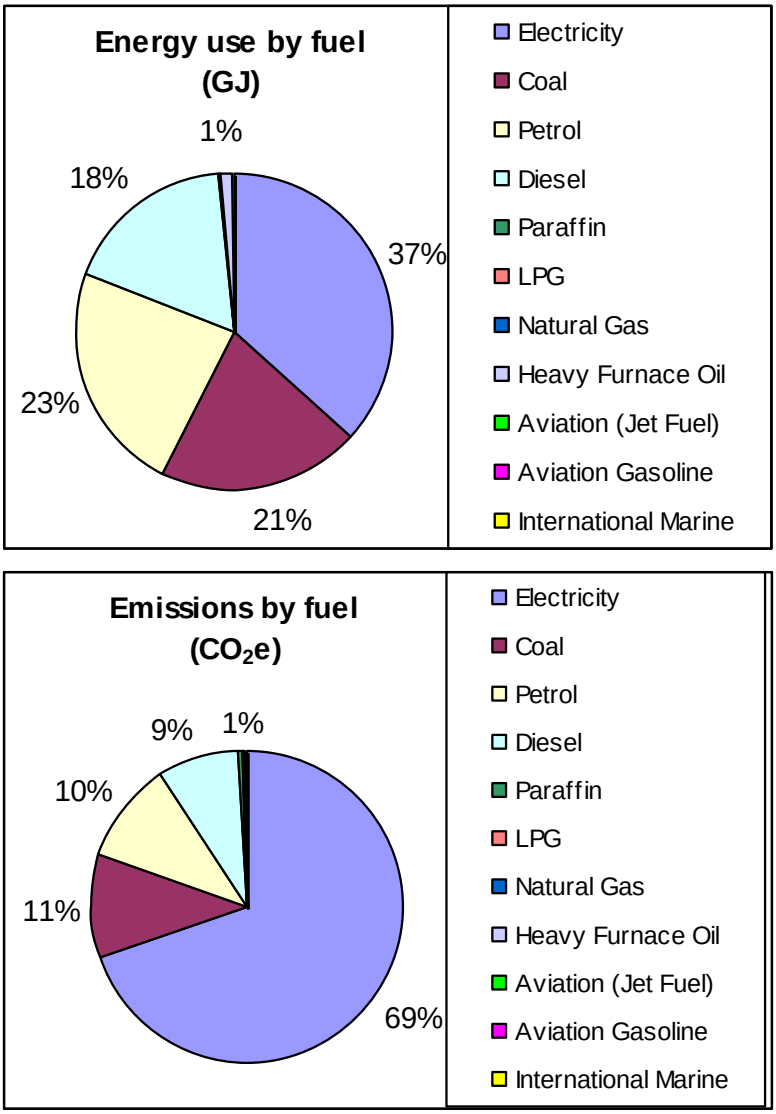


Figure 15: Energy use and energy-related emissions by fuel type in Cape Winelands

The district energy picture reveals heavy reliance on fossil fuels, which accounts for close to 100% of the energy sources (5% of electricity is sourced from nuclear energy in the national mix). Fire wood for household consumption occurs to a small extent, but use of this fuel is difficult to quantify and is used in such small quantities (from an energy perspective) that is unlikely to be visible in the district energy picture. Heavy dependence on fossil fuels renders the district vulnerable to price increases and shocks, supply disruptions and possible costs associated with carbon pricing in the future.

Transport fuels (petrol and diesel) account for 40% of the energy consumed in the district, with electricity and coal at 37% and 21% respectively. Although only just over a third (37%) of energy consumed, electricity accounts for 69% of GHG emissions. This is due to it having a high emissions factor resulting from its source in low grade, 'dirty' coal.

Coal, according to Air Quality data, is used in the district for boilers (unspecified) and in brickfields and likely in some form of agri-processing.

Sustainable energy staff capacity and initiatives are captured in Appendix 4.

Sector Disaggregation

It is evident from the figure below that the transport sector, followed closely by industry, dominates in terms of energy use. However, GHG emissions picture is slightly different, in that the electricity-consuming sectors, notably those relating to the built environment (residential and commercial) together with industry account for the majority of GHG emissions in the district. In the Cape Winelands, all sectors more or less contribute equally to the overall GHG emissions. Cumulatively, the built environment together with industry and transport are probably the most important sectors to manage with respect of carbon emissions. It is likely that a large amount of the transport fuels is associated with tourism and the transportation of wine-related and other manufactured goods along Route 62 traversing the district. This means that this sector is difficult to manage, with much of the responsibility lying in provincial and national spheres.

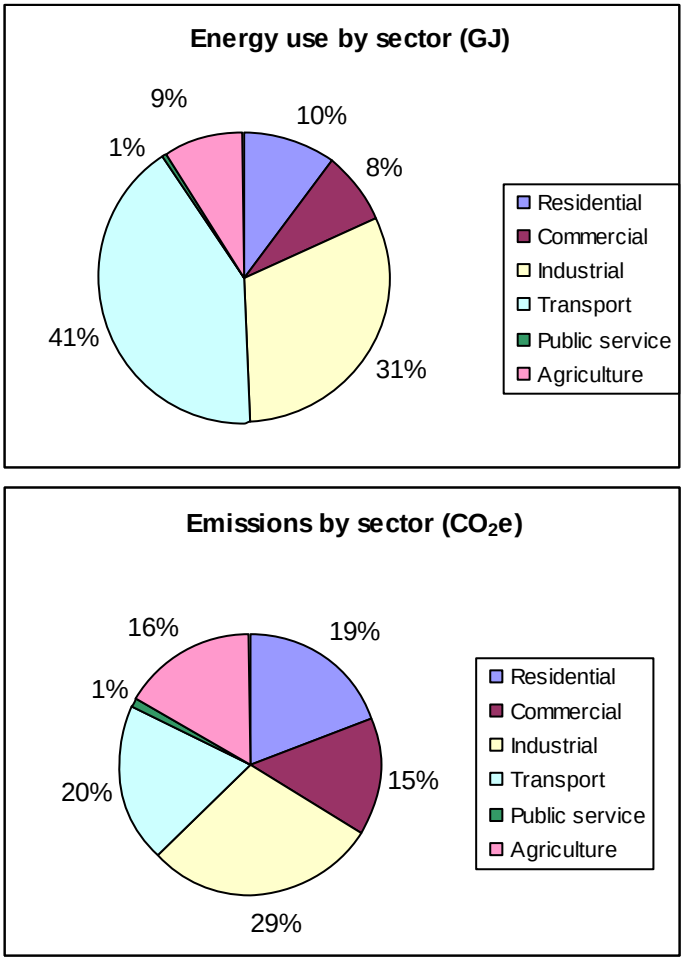


Figure 16: Energy use and energy-related emissions by sector in Cape Winelands

Given the importance of electricity in GHG emissions and the fact that the local built environment (commercial and residential) contributes over a third (34%) to the district emissions, this is an important sector to understand. As illustrated in the figure below, the residential and commercial sectors combined contribute 49% of consumption (28% and 21% respectively), with industry contributing 24% and agriculture 23%. This means that there is substantial opportunity within the built environment (residential and commercial) for realising energy efficiencies. It would also be worth understanding the use of electricity within agriculture and industry in order to evaluate the efficiency potential of these sectors.

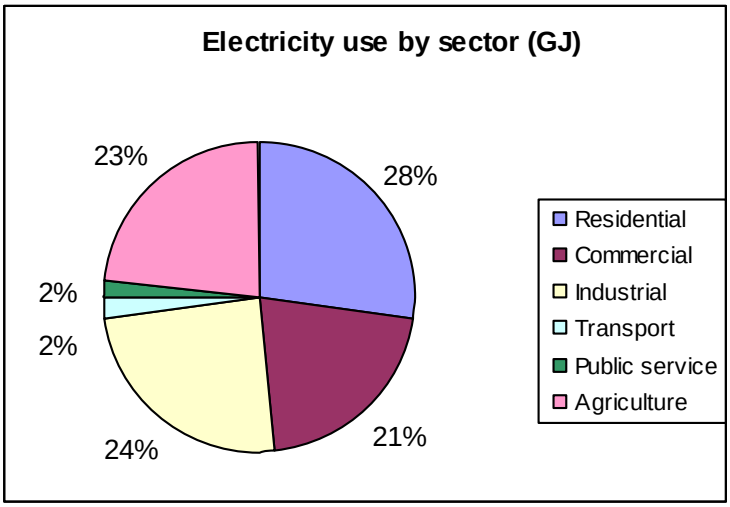


Figure 17: Electricity use by sector in Cape Winelands

The following are amongst the top ten municipal-distributed electricity users (for those municipalities that provided this information):

- the public sector is a notable electricity consumer; this includes prisons, hospitals and parastatal companies, such as Spoornet
- small agro industries, such as agricultural feed producers, dairies, wineries, fruit packing companies, chicken farms and abattoirs represent the industrial component, of top electricity consumption
- tourism – spas and casinos
- retail – shopping centres and malls

Residential Sector

National statistics on household energy consumption for the district indicate that use of electricity for lighting in the district stands at around 93%. Lighting provides a good proxy for level of electrification; and this figure is strong against a national average of 82% electrified. The district figures for electrification backlog stand at:

Table 20: Electrification backlog in Cape Winelands

Municipality	Projected total households 2009 (with 1 % growth)	Backlog (no growth)	Backlog (1% household growth)	Backlog according to municipal own data
Breede Valley	38 030	2 181	4 732	none
Drakenstein	49 527	6 130	9 454	none
Langeberg	23 332	1 500	3 066	185 formal households
Stellenbosch	32 057	1 014	3 166	
Witzenberg	21 654	2 809	4 263	1 064 informal households
District total	**164 600**	**13 634**	**24 681**	

Source: National Department of Energy, 2009, and Municipal Questionnaires (SEA, 2012)

Table 21: Free Basic Electricity Grant in Cape Winelands

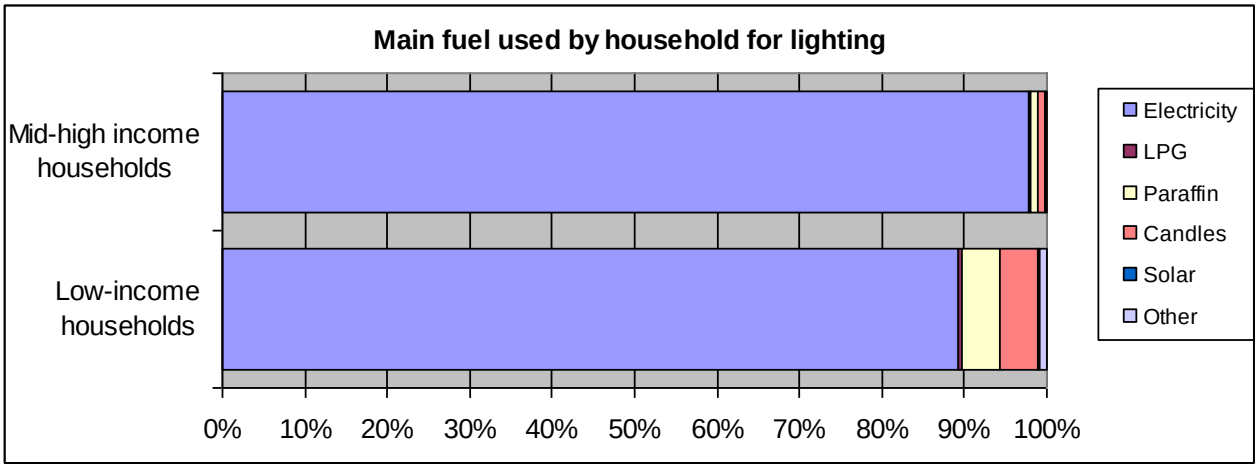
Municipality	Households receiving FBE grant
Breede Valley	6227
Drakenstein	16 405
Langeberg	4395
Stellenbosch	3252
Witzenberg	3076
District total	**33 353**

Source: Municipal Questionnaires (SEA, 2012)

It would be useful to track the proportion of households qualifying for an electricity subsidy over the total number of households, over time. This would provide some idea of whether this is growing relative to total consumption.

In the instance of lighting, the 10% of non-electrified households are using a combination of candles and paraffin lamps for lighting. The below figures also indicate that even where electrification is in place, many poorer households continue to use multiple fuels to meet their energy needs, with substantial paraffin for cooking (and relatively high amounts of LPG) and paraffin and wood for space heating. Compared with other district municipalities, the Cape Winelands district is in the middle of the range where percentage of low-income electrified households is concerned. The percentage of low-income households that use non-electric fuels for space heating and cooking is very low (only the West Coast shows lower values). This may mean that there is a relatively lower level of energy poverty; electrified households can afford to use the electricity for space heating and cooking, without having to fall back on alternate sources despite being electrified.

It is interesting to note the rather large proportion of low-income households using LPG, when compared with high-income households. Usually, paraffin is used as the main alternative cooking fuel. This may be due to the fact that two out of the four large LPG distributors are situated in Langeberg and Stellenbosch - the others are in Cape Town and Mossel Bay (Eden).



*Can be used as a proxy for electrification - households that are electrified tend to use the electricity for lighting, first and foremost

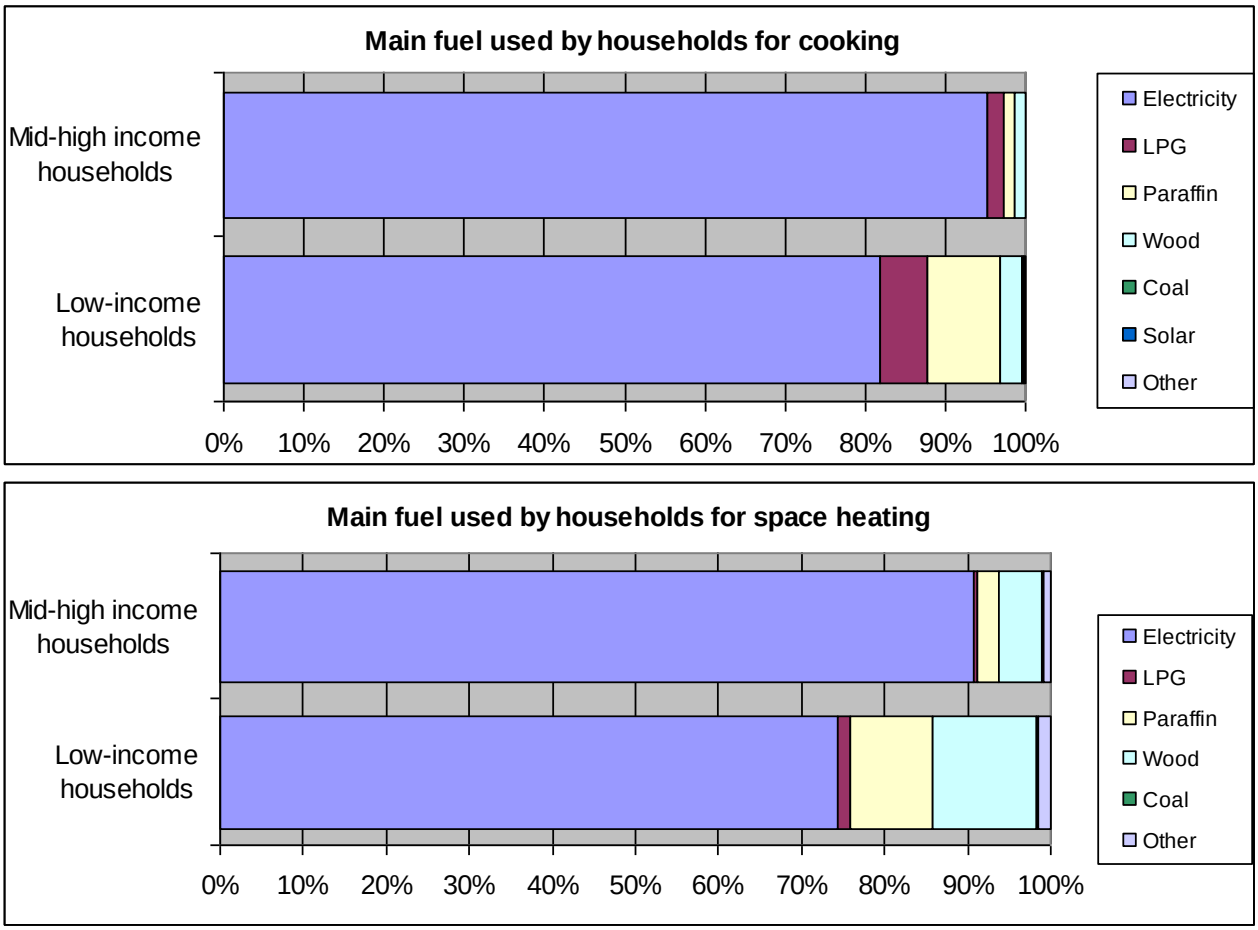


Figure 18: Fuel used by households for lighting, cooking and heating in Cape Winelands

Commerce and Industry

Agriculture, industry and commerce are all important energy consumers in the district, although overall contribution by the district to provincial GVA (9%) and energy consumption (7%) is relatively small. As noted above, the built environment together with industry can hold energy efficiency potential. When examining the top ten electricity users (for those municipalities that provided this information), the following stand out:

- small agro industries, such as agricultural feed producers, dairies, wineries, fruit packing companies, chicken farms and abattoirs represent the top electricity consumers in the industrial sector
- retail, shopping centres and malls, are also some of the big electricity users

While there may be some industrial process efficiencies to be gained within the smaller, agro-industries, the other large consumers, consumption largely relates to the built environment.

Transport

Given the paucity of detailed transport data, there is there is no modal split for the province at this stage. This could be worked on through establishing estimated passenger kilometres and relating this to fuel consumption. However, with the lack of data on the transport characterisation of towns along national roads, small towns versus larger metros, etc, this was felt to be premature. Data has been gathered on vehicle ownership and the growth of this can be tracked over time.

Table 22: Vehicle population in Cape Winelands

Vehicle type	Cape Winelands	Central Karoo	Eden	Overberg	West Coast	Cape Town
Public	3 953	198	3 125	1 273	1 596	28 943
Private	105 044	5 569	101 226	41 321	48 756	787 434
Other	12 134	462	7 709	5 411	9 785	14 800
Freight	63 072	4 848	59 463	28 373	40 863	247 712
Vehicles per capita (2011)	**0.24**	**0.22**	**0.31**	**0.36**	**0.36**	**0.27**

Local Government

Although local government only consumes around 2% of total energy consumption in the district, it has an important role to play as it is one of the single largest consumers in each municipality. It can also lead by example in sustainable energy drives such as building and operations efficiency and vehicle fleet management, which offer important opportunities for financial and energy savings. Within local government consumption, the breakdown between sectors is as follows:

Table 23: Local government energy use by service in Cape Winelands

Local government energy use by service	GJ
Buildings & Facilities	88 632
Water & Waste Water Treatment	17 011
Street and Traffic Lights	56 902
Vehicle Fleet	66 893

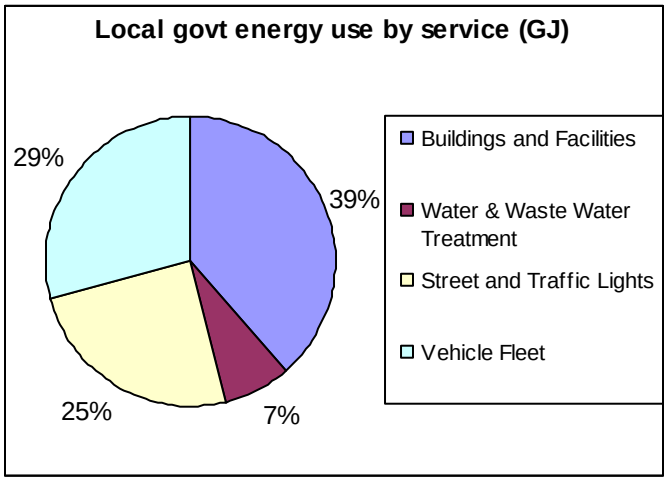


Figure 19: Local authority energy consumption in Cape Winelands

Waste figures are not very clear at this stage. The average waste per capita in the district for 2009 was 0.86 tonnes per annum. Waste contributes significantly to global warming emissions and managing this sector to reduce these is a very important response in mitigating climate change.

All municipalities in the district appear to have between 46 to 162 full time engineers in their Electricity departments and a few part-time staff. In most municipalities in the district, no staff is engaged in electricity savings, climate change and other initiatives, with the exception of Breede Valley which has 2 full-time staff dedicated to electricity/energy saving awareness and solar water heater rollout. These roles are not part of any specific job description. No municipalities in the district have reported on policies addressing the sustainable energy or climate policy goals of the Western Cape Government, apart from Drakenstein, which has developed a green building manual, a municipal fleet fuel monitoring tracking system, and has a residential load management and energy efficient programme in place.

Most of these initiatives by Drakenstein were implemented after 2009, and while the municipality has no dedicated staff assigned to implement the above, they are performed broadly in conjunction with other duties.

Conclusion

While the energy consumption in this district is small, and it represents a very small part of the total provincial consumption, important saving opportunities exist within the built environment. These could target large retail outlets and provincial and local government.

Key Issues

- The Cape Winelands District has low levels of energy poverty when compared to other districts (only the West Coast is lower)
- There is a relatively high proportion of low-income households using LPG as cooking fuel. This may be encouraged in the mid-high income band as well, in order to reduce peak electricity demand, since two out of the 4 major LPG distributors are situated in this district.
- Agriculture, industry and commerce are all large energy consumers in the district
- The top municipal-distributed electricity consumers include the public sector (prisons, hospitals and parastatal companies, such as Spoornet), agro-industries (agricultural feed producers, dairies, wineries, fruit packing companies, chicken farms and abattoirs), tourism (spas and casinos) and retail (shopping centres). Local municipalities can lead by example in sustainable energy drives such as building and operations efficiency and vehicle fleet management
- A heavy dependence on fossil fuels renders the district vulnerable to price increases and shocks, supply disruptions and possible costs associated with carbon pricing in the future.
- Although only just over a third (37%) of energy consumed, electricity accounts for 69% of GHG emissions. This is due to it having a high emissions factor resulting from its source in low grade, 'dirty' coal.

ENERGY DATA OVERVIEW: CENTRAL KAROO

Introduction

Central Karoo is one of the smallest districts situated in the Western Cape Province, with a population of 56,232. The District's land area stretches an estimated 38,853 km^2, making Central Karoo the largest district area-wise. The district comprises of three municipalities: Prince Albert, Laingsburg and Beaufort West. The district experiences high levels of poverty, unemployment and inequality. In 2010, 33% of people were living in poverty.[17]

Despite high poverty and inequality, the district has the highest proportion of households who have access to formal housing (97%) and the lowest proportion (1.6%) of households residing in informal settlements. In terms of access to electricity within the district, Beaufort West Municipality has the highest number of households with access to electricity, followed by Prince Albert. Laingsburg has the lowest number of households with access to electricity (National Department of Energy, 2009).

Major activities taking place in the district include inter-alia:

- Agriculture, employing 23% of the workforce.
- Wholesale and retail sector, employing approximately 18% of the workforce and an important source of informal employment.
- Transport is an economic driver in the district as a result of traffic on the N1 and N12 national roads. There is potential for growth in this regard.
- The district is highly rich in minerals such as uranium and shale gas. There has been increasing interest in mining of these minerals in the district. However, the potential environmental impact associated with this activity is of concern for the district.
- Finance and business services contribute substantially to Central Karoo's GDP and employment.

The report provides a brief energy picture for the Central Karoo District Municipality and highlights key areas or issues for attention.

The energy picture

Table 24: Sustainable energy indicators in Central Karoo

Key sustainable energy indicator	Unit of measure	District Value 2009	Provincial Value 2009	National Value 2009*
Energy consumption per capita	GJ/capita	56	64	53
GHG emissions per capita	tCO_2e/capita	5.5	8.0	7.7
Energy per GDP (R' mill)	GJ/GDP	2, 514	1,428	1,094
GHG emissions per GDP(R' mill)	tCO_2e/GDP	245	178	159

*Source: Department of Energy: South African Energy Synopsis 2010: data for 2006 only/SA's 2nd National Communication, 2011, data for 2000 only.

The district has relatively high average annual carbon emissions level of 7.3 tonnes per person – higher than the global average of 4 tonnes per capita, but lower than the provincial and the national average of 8.0 and 7.7 tonnes per capita. This carbon footprint is substantially higher within industrial towns compared to non-industrialised towns within the district. However, when looking at the of energy consumed per unit of economic output and as well GHG emissions per unit of economic value, then the area can be seen to be a relatively high user of energy and carbon emitter. The high carbon footprint can be attributed to fuel use by traffic passing through the towns on the major highways.

[17] Central Karoo District IDP, 2012 - 207

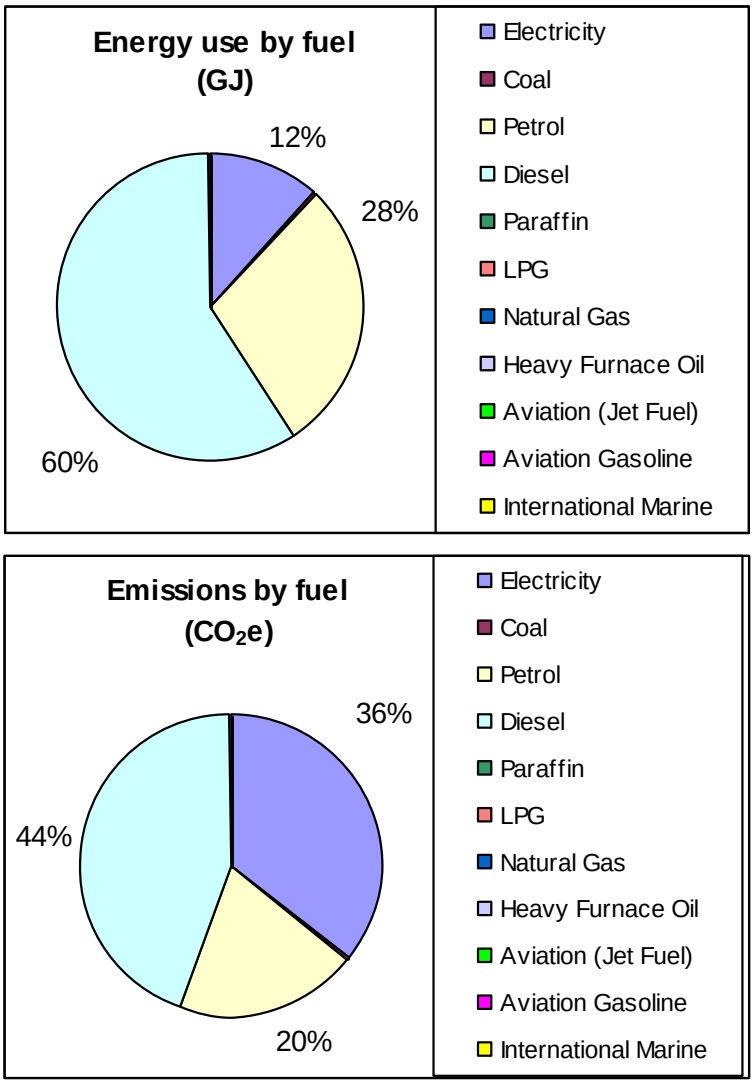


Figure 20: Energy use and energy-related emissions by fuel in Central Karoo

In Central Karoo, the use of liquid fuel (diesel and petrol) dominates at 88%. This is indicative of the intensive use of transport as a result of the N1 and N12 national roads that run through this district. The towns on these roads are a major fuel stop for trucks passing through. As a result, this fuel use cannot be managed by the municipalities in this area, as it does not represent internal energy use.

Electricity is the second major source of energy consumption in the district. It contributes dispropotionally to GHG emissions due to the fact that it is created largely by the burning of "dirty" fuel in coal-fired power stations. Beaufort West Municipality has started to reduce electricity demand by introducing load controls and power factor correction in order to conserve electricity.

Sector Disaggregation

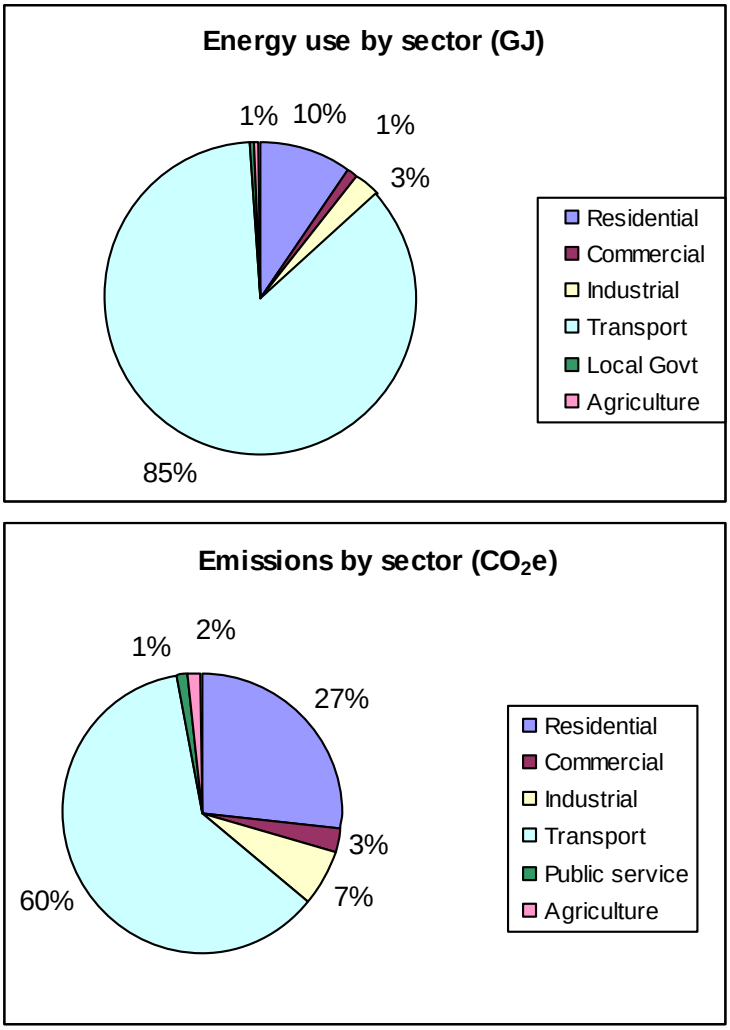


Figure 21: Energy use and energy-related emissions by sector in Central Karoo

A large proportion of energy consumption in the district is consumed within the transport sector. This could be attributed to the use of the N1 and N12 national roads. At 10%, the residential sector accounts for relatively smaller proportion of the district energy consumption, but a relatively large proportion of the GHG emissions (27%) due to the use of emission-intensive electricity. Industry accounts for only 3% of energy consumption in the district.

Understanding sectoral contributions to district emissions enables effective management for reducing sectoral GHG emissions. Sector GHG emissions in Karoo point to high impact of the transport, residential and industrial sectors.

Given the notable contribution of electricity to GHG emissions, it is important to understand which sectors are the large consumers of electrcity. The residential, transport (rail) and industrial sectors consume a significant amount of electricity in the district. The top municipal-distributed electricity users in the area include rail, petrol stations, abattoirs, hospitals, retirements villages, school residences, hotels and grocery stores.

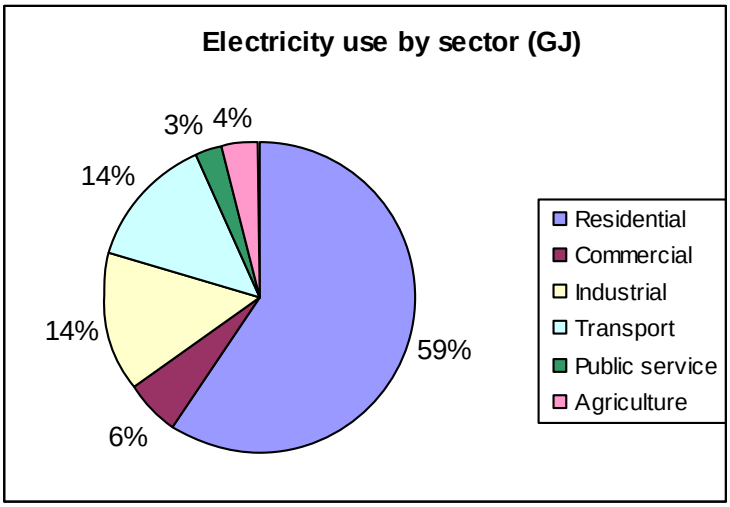


Figure 22: Electricity use by sector in Central Karoo

Residential Sector

Access to convenient, affordable, safe, clean energy sources such as electricity, is considered a key component of socio-economic development. The National Electrification Programme was initiated in 1994 to address the electricity backlog by 2014. Approximately 18% of the total population still do not have access to electricity. According to the Department of Energy (2009), approximately 196[18] households in the Central Karoo District had no access to electricity in 2009. However, studies show that even with 100% access to electricity, low-income households will use multiple fuels to meet their energy needs.

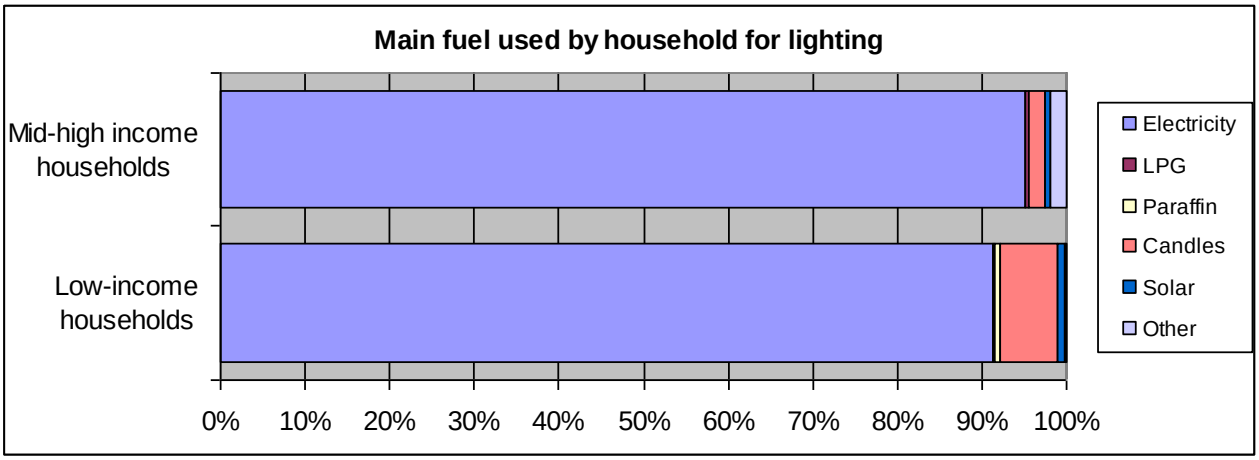


Figure 23: Fuel used by households for lighting in Central Karoo

The use of electricity for lighting can be used as a proxy of electrification. Though the level of electrification is relatively high, electricity is generally seen to be too expensive to use for end-uses other than lighting, e.g. cooking and space heating. This is the reason that low-income electrified households still use a mix of fuel sources for heating and cooking (see figures below). This highlights the issue of energy affordability/energy poverty. Solar power is used for lighting on farms or outlying areas where access to the electricity grid is too costly.

[18] Projected figure with 1% growth

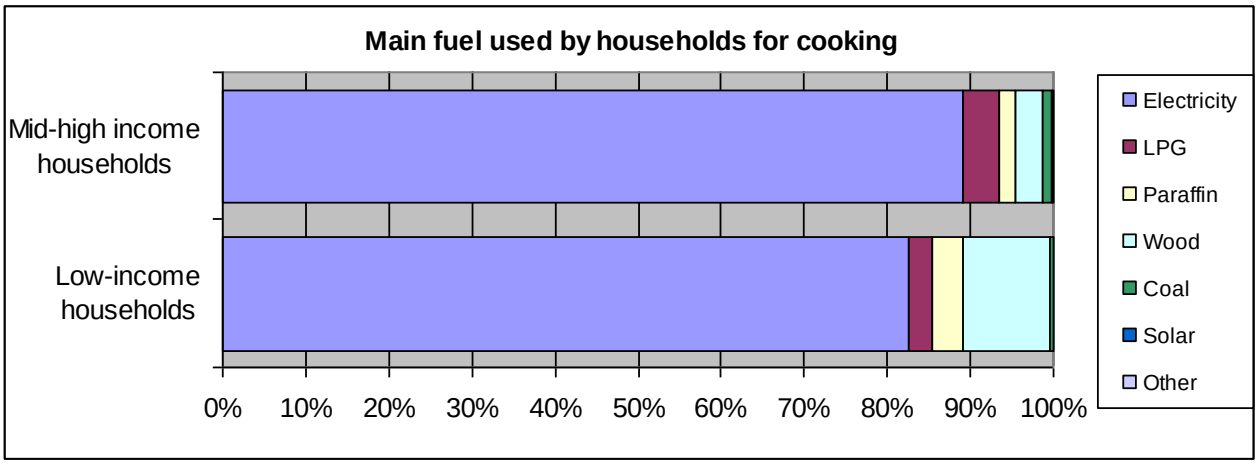


Figure 24: Fuel used by households for cooking in Central Karoo

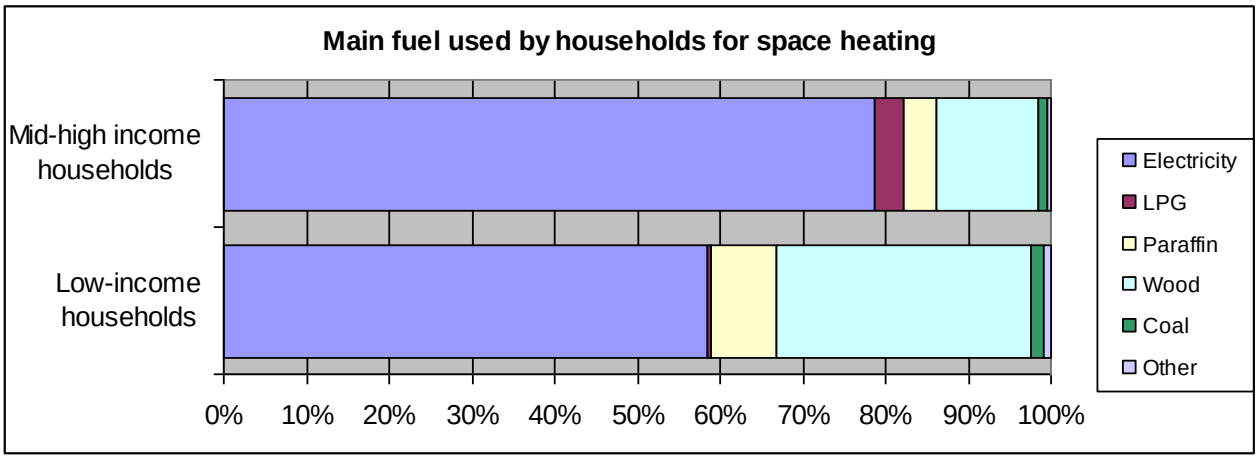


Figure 25: Fuel used for space heating in Central Karoo

A large amount of wood and paraffin is used for space heating and cooking; far larger than any other district municipality, which indicates that energy poverty is greater here than in other districts. Households may have access to electricity, but are not using it as readily for cooking or space heating due to the high costs. Roughly a third of low-income households use wood for space heating in Central Karoo. This correlates with the fact that 33% of people in the district are living in poverty (see introduction above). This may have a large impact on the district's environment, as the Karoo does not have high levels of vegetation.

Transport

Given the lack of detailed transport data, there is no modal split for Central Karoo at this stage. This could be worked on through establishing estimated passenger kilometres and relating this to fuel consumption. However, with the lack of data on the transport characterisation of towns along national roads, small towns versus larger metros, etc, this was felt to be premature. Data has been gathered on vehicle ownership and the growth of this can be tracked over time.

Table 25: Vehicle population in Central Karoo

Vehicle type	Cape Winelands	Central Karoo	Eden	Overberg	West Coast	Cape Town
Public	3 953	198	3 125	1 273	1 596	28 943
Private	105 044	5 569	101 226	41 321	48 756	787 434
Other	12 134	462	7 709	5 411	9 785	14 800
Freight	63 072	4 848	59 463	28 373	40 863	247 712
Vehicles per capita (2011)	**0.24**	**0.22**	**0.31**	**0.36**	**0.36**	**0.27**

Despite the large amount of liquid fuel use in the district (88% of all fuel consumed), car ownership is the lowest out of all the Western Cape districts/metros at 0.22 vehicles per capita. This indicates that most of the liquid fuel is consumed by vehicles passing through the towns situated on national roads in this district.

Local Government

Local government, being significant distributers of electricity, are ideally placed to influence the energy use of other sectors, as they are major employers and the primary planners and service providers in the municipality. Energy cost is a variable cost, which can be controlled by reducing wasteful energy consumption. Greater energy efficiency means lower financial costs and improved competiveness. To do this, human capacity within the municipalities is important to drive such projects. However, the district does not have an environmental management section or environmental officer within its organisational structure and is heavily dependent on the support provided by the National Department of Environmental Affairs. In Beaufort West, there is only three part-time staff members dedicated to electricity, climate change projects and energy saving campaigns. One municipality did not respond to the survey questionnaire for this report, which many indicate severe staff capacity constraints.

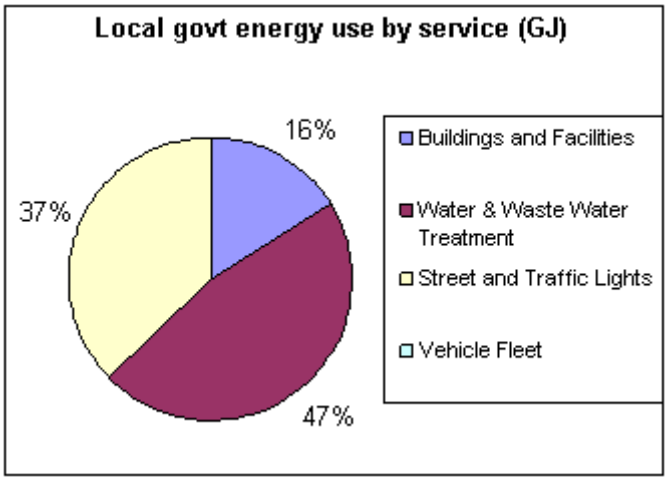


Figure 26: Local government energy use in Central Karoo

The above graph shows a high proportion of electricity use in street/traffic lighting and waste water treatment works. Caution should be applied before drawing conclusions though, as vehicle fleet data had not been available for any of the local municipalities in the Central Karoo District. Given the above figure, there may be opportunities for municipalities to retrofit street and traffic lights with efficient options, e.g. light emitting diode (LED) signals at traffic intersections. There may also be scope to improve the efficiency of water and waste treatment plants, e.g. if old pumps need replacement, efficient options could be considered. Energy savings can also be achieved within the buildings and facilities sector. However, there are no sustained energy efficiency programmes in buildings. Municipalities can be innovative in this regard.

Conclusion

The Central Karoo District appears to have some of the highest levels of energy poverty and staff capacity constraints in the Western Cape. A considerable amount of support may be required from other government entities for the area to progress in terms of sustainable energy management. Keeping this in mind, though, a large proportion of the energy use within its boundaries is not open to management by the area, as it is caused by traffic passing through on the national highways.

Key Issues

- In Central Karoo, the use of transport liquid fuel (diesel and petrol) dominates at 88%. This is indicative of the intensive use of transport as a result of the N1 and N12 national roads that run through this district. The towns on

these roads are a major fuel stop for trucks passing through. As a result, this fuel use cannot be managed by the municipalities in this area, as it does not represent internal energy use.

- Electricity is the second major source of energy consumption in the district. It contributes disproportionally to GHG emissions due to the fact that it is created largely by the burning of "dirty" fuel in coal-fired power stations, i.e. the residential sector uses 10% of the energy, but generates 27% of the GHG emissions.
- A large amount of wood and paraffin is used for space heating and cooking; far larger than any other district municipality, which indicates that energy poverty is greater here than in other districts. Households my have access to electricity, but are not using it as readily for cooking or space heating due to the high costs.
- Roughly a third of low-income households use wood for space heating in Central Karoo. This correlates with the fact that 33% of people in the district are living in poverty (see introduction above). This may have a large impact on the district's environment, as the Karoo does not have high levels of vegetation.

ENERGY DATA OVERVIEW: EDEN

Introduction

Eden District is situated in the Western Cape Province with an estimated population of 537,431.[19] The District's total surface area is estimated at 23,332 km^2. The district comprises of seven municipalities: Bitou, George, Kannaland, Knysna, Hessequa, Mossel Bay and Oudtshoorn.

The district experiences high levels of poverty, unemployment and inequality. In 2009, approximately 19% of the working population were unemployed. More than half (55%) of Eden's population lived below poverty line in 2007.[20]

Major activities taking place in the district include 1) finance and insurance industry, which is the fastest growing and the largest contributor to economic growth with an estimated annual contribution of 5.4% between the period 1996 and 2009; 2) manufacturing, wholesale and retail and accommodation sectors, which also contribute significantly to the economic growth of the district. The wholesale, retail and construction sectors are the major employers in the district. Tourism along the Garden Route results in particular energy management and waste challenges, as infrastructure and supply has to cope with large tourism season-driven peaks. This would mean that distribution infrastructure has to be able to cope with a seasonal peak demand that is far higher than the yearly average demand.

The report provides a brief energy picture for Eden District Municipality and highlights key areas or issues for attention.

The energy picture

Table 26: Sustainable energy indicators in Eden

Key sustainable energy indicator	Unit of measure	District Value 2009	Provincial Value 2009	National Value 2009*
Energy consumption per capita	GJ/capita	52	64	53
GHG emissions per capita	tCO_2e/capita	7.3	8.0	7.7
Energy per GDP (R' mill)	GJ/GDP	1 626	1,428	1,094
GHG emissions per GDP(R' mill)	tCO_2e/GDP	231	178	159

*Source: Department of Energy: South African Energy Synopsis 2010: data for 2006 only/SA's 2nd National Communication, 2011, data for 2000 only

The district has an average annual carbon emissions level of 7.3 tonnes per person; higher than the global average of 4 tonnes per capita, but on a close par with provincial average and the national average of 8.0 and 7.7 tonnes per capita respectively. This carbon footprint is substantially higher within industrial towns compared to non-industrialised towns. However, when looking at the of energy consumed per unit of economic output and as well greenhouse gas emissions per unit of economic value, then the area can be seen to be a relatively high user of energy and carbon emitter.

[19] Eden IDP Review, 2011/2012
[20] StatsSA, Community Survey Data, 2007.

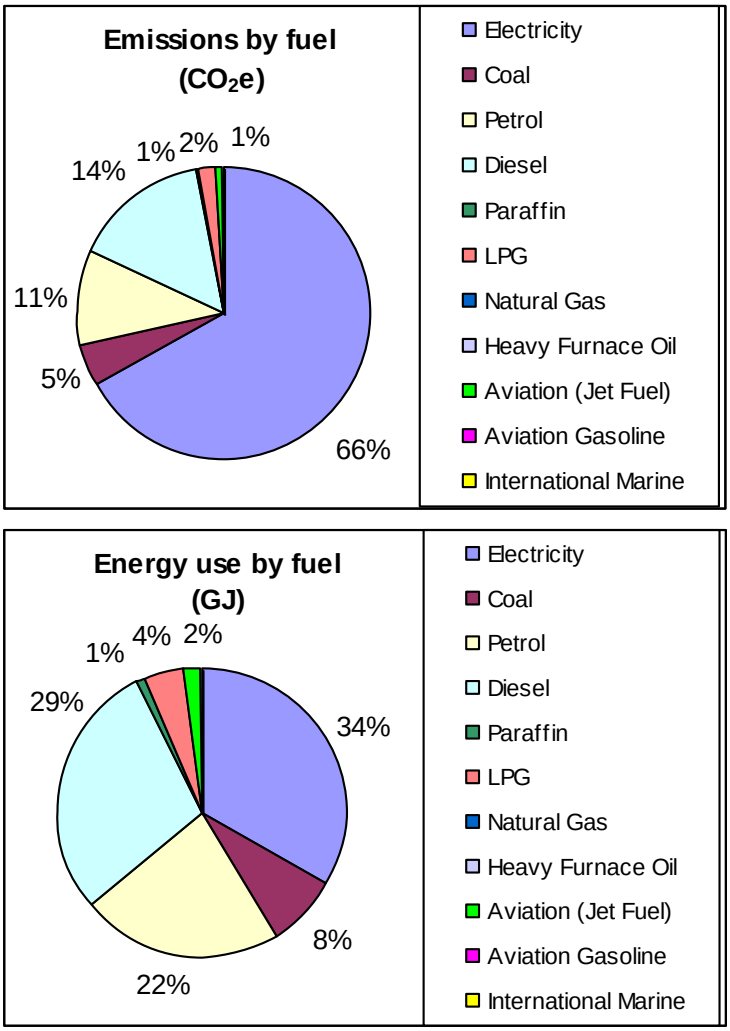


Figure 27: Energy use and energy-related emissions by fuel type in Eden

Identifying fuel types responsible for emissions within the district enables more effective strategic plannning around sustainable fuel use. Liquid fuel (diesel and petrol) represents more than half of all energy used within the district, with electricity consumption at about a third of the amount. Electricity contributes to 66% of GHG emmisions. This is because electricity is fossil-fuel based; largely from coal-fired power stations. By contrast, petrol and diesel contribute 25% towards emissions.

Sector Disaggregation

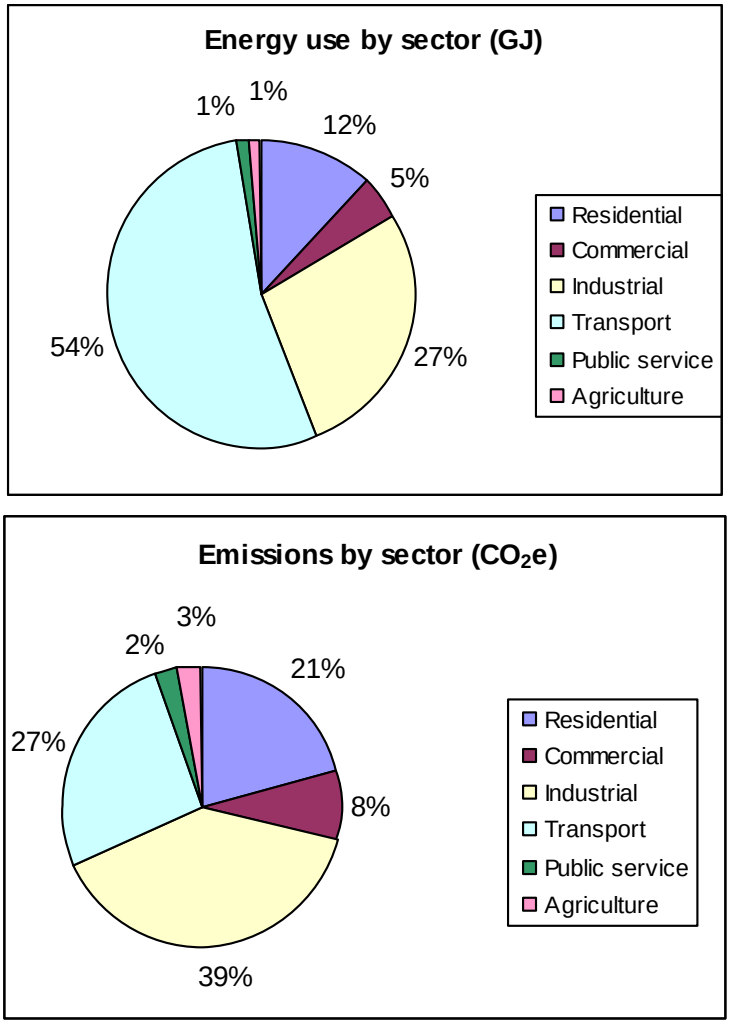


Figure 28: Energy use and energy-related emissions by sector in Eden

The transport sector accounts for the largest proportion of energy consumption in the district (54%) , follwed by the industrial sector at 27%. The high use of energy in the industrial sector can be attributed to PetroSA in Mossel Bay and the fact that the Western Cape's second-largest town (George) is located in the Eden District. The residential sector accounts for 12% of energy consumption in the district.

Understanding sectoral contributions to district emissions enables effective management for reducing sectoral carbon emissions. Sector carbon emissions in Eden point to the high impact of the industrial, transport, and residential sectors. There is an opportunity for the district to embark on energy efficiency projects aimed at reducing sectoral carbon emissions. Targets in reducing sectoral emissions can be included in the district and municipal Integrated Development Plans.

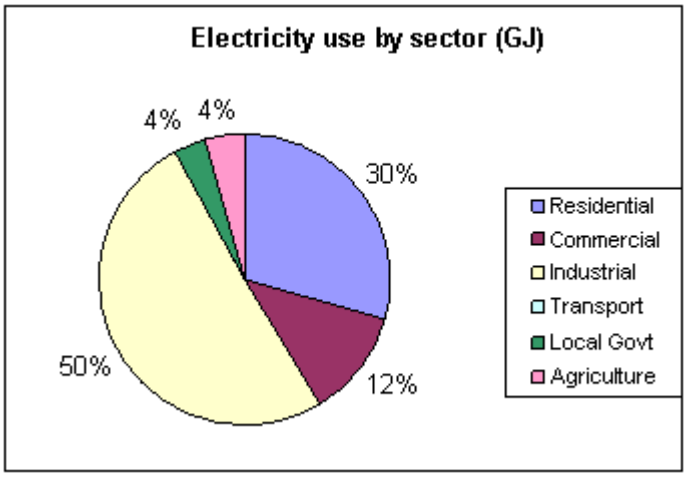


Figure 29: Electricity use by sector in Eden

The top 10 users of municipal-distributed electricity in local municipalities in the Eden District includes (in order of frequency of occurrence) retail, real estate, (food) manufacturing, golf estates, public service (police stations, municipal pumps, etc), hotels, abattoirs and transport (airport, rail). The Eden District has started to reduce electricity demand by introducing geyser load controls and efficient street lighting retrofits.

Residential Sector

Access to convenient, affordable, safe, clean energy sources such as electricity, is considered a key component of socio-economic development. The National Electrification Programme was initiated in 1994 to address the electricity backlog by 2014. According to the Department of Energy (2009), approximately 8, 670[21] households in Eden District had no access to electricity in 2009. However, studies show that even with 100% access to electricity, households will use multiple fuels to meet their energy needs due to the cost of electricity.

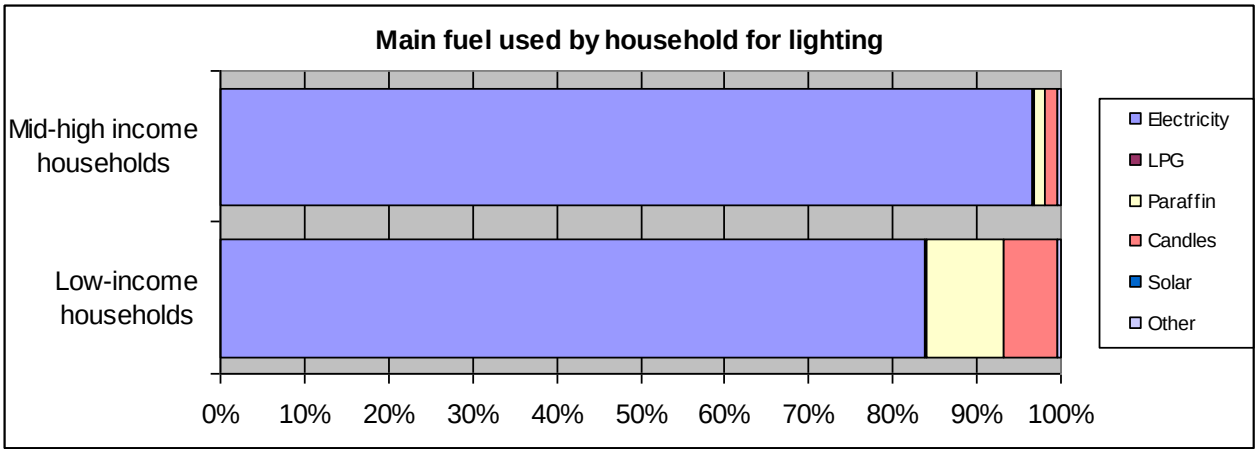


Figure 30: Fuel used by households for lighting in Eden

Using the above percentage of electricity used for lighting as a proxy for electrification, it can be deducted that roughly 85% of low-income households are electrified. The use of candles and parraffin by the low-income households in the district is a cause for concern. A number of fires and deaths are as a result of the use of paraffin and candles, particularly in informal settlements. Household energy use and awareness raising are some of the campaigns that the district and its municipalities can embark on.

[21] Projected figure without growth

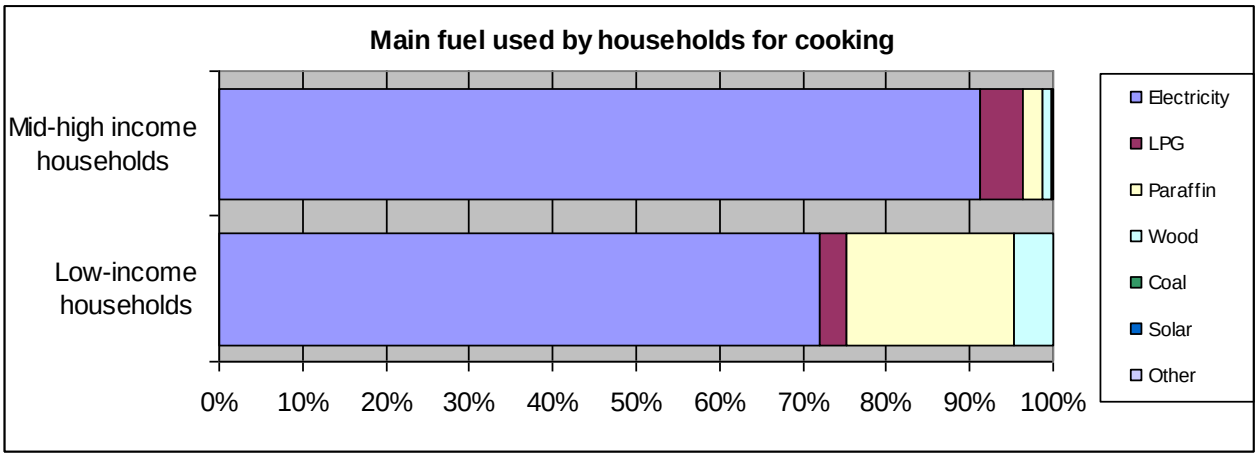


Figure 31: Fuel used by households for cooking in Eden

A relatively large amount of paraffin and wood is used by low-income households for cooking (a larger percentage than in any other district). This can be attributed to the high level of poverty (see Eden introduction) and the inability of households to afford to pay for electricity, therefore resorting to alternative energy sources.

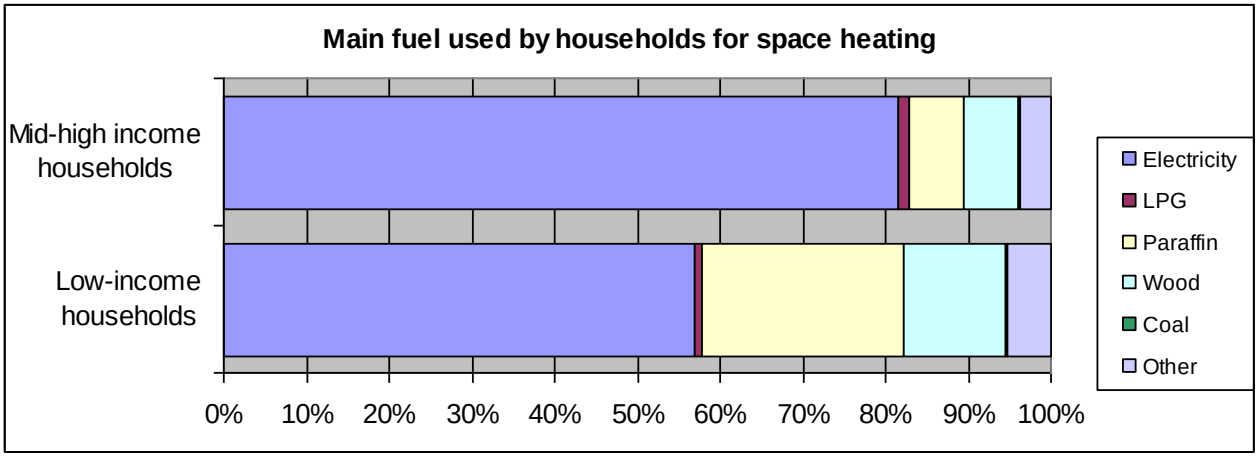


Figure 32: Fuel used by households for space heating in Eden

The Eden and Central Karoo Districts have the lowest percentage of households using electricity for space heating (both below 60%, with Eden slightly lower), illustrating the highest level of energy poverty in these districts. The use of paraffin and wood for space heating poses a fire hazard with repercussions for disaster management.

Transport

Given the lack of detailed transport data, there is no modal split for Eden at this stage. This could be worked on through establishing estimated passenger kilometres and relating this to fuel consumption. However, with the lack of data on the transport characterisation of towns along national roads, small towns versus larger metros, etc, this was felt to be premature. Data has been gathered on vehicle ownership and the growth of this can be tracked over time.

Table 27: Vehicle population in Eden

Vehicle type	Cape Winelands	Central Karoo	Eden	Overberg	West Coast	Cape Town
Public	3 953	198	3 125	1 273	1 596	28 943
Private	105 044	5 569	101 226	41 321	48 756	787 434
Other	12 134	462	7 709	5 411	9 785	14 800
Freight	63 072	4 848	59 463	28 373	40 863	247 712
Vehicles per capita (2011)	**0.24**	**0.22**	**0.31**	**0.36**	**0.36**	**0.27**

Eden has the second-highest number of vehicles per capita. Given the high energy poverty in the area (as discussed above), this may be an indication of high wealth inequality.

Local Government

Local government while being small energy users relative to other sectors and significant distributers of electricity, they ideally placed to influence the energy use of others, as they are major employers and the primary planners and service providers in the municipality. Energy cost is a variable cost, which can be controlled by reducing wasteful energy consumption – greater energy efficiency means lower financial costs and improved competiveness.

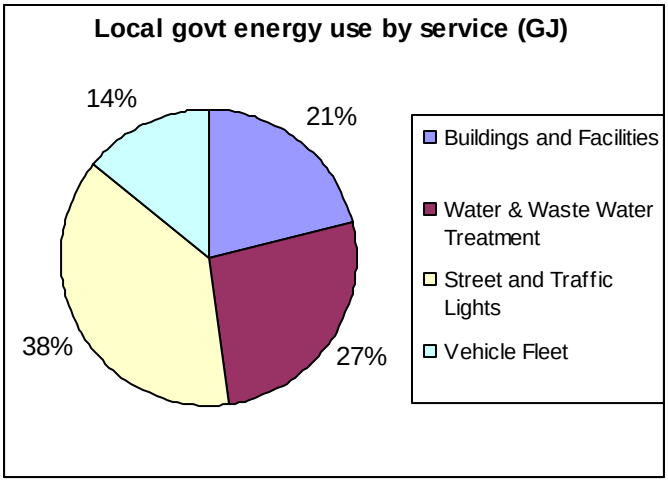


Figure 33: Local government energy use in Eden

Street and traffic lights make up the majority of total energy consumption in the district. There are opportunities for municipalities to upgrade streetlights and traffic lights – such as the use of light emitting diode (LED) signals at traffic intersections. This has a significant potential for savings on energy use, financial savings and reduced emissions. The water and waste water treatment plants as well as vehicle fleet energy use is underreported, as 5 of the 7 local municipalities in this district were unable to report on either or both of these figures. There is a scope to improve the efficiency of water treatment. Substantial energy savings within building and facilities sector can also be achieved. It would be interesting to see what the government energy use picture would look like if all data was available. It is suspected that waste water and water treatment will contribute a much higher percentage of the pie chart, as South Africa's largest desalination plant, which is very energy intensive when in use, is situated in the Eden District in Mossel Bay. Unfortunately no data was available on waste water and water treatment works energy use in Mossel Bay. Government energy use would require further studies for clarification.

Conclusion

While the energy consumption in this district is small and it represents a very small part of the total provincial consumption (8% of the provincial total), important saving opportunities exist within the built environment as well as the industrial sector.

The Eden District experiences the highest level of energy poverty of all the districts/metros. It's per capita energy and waste GHG emissions footprint is in line with the provincial average, but this masks a large range; from 3 tonnes per capita in Kannaland and Oudtshoorn, and 5 in George (the largest town after Cape Town), to 8 in Mossel Bay (a heavy industrial area). Eden has the second-highest vehicle ownership, which, combined with the high energy poverty, may indicate large wealth inequality. Liquid fuel represents the largest amount of energy consumed in the district, while electricity use is the cause of the most GHG emissions. Industry uses about half of the district's electricity, with the residential sector consuming a third.

Key Issues

- Heavy industry is situated in the Eden District (e.g. in Mossel Bay).
- A national road runs through the district, which increases liquid fuel use that is outside the management control of local municipalities.
- South Africa's largest desalination plant is situated in Mossel Bay. Though not used often, it is very energy intensive when in use.
- The district has the highest energy poverty level in the Western Cape, when based on the percentage of non-electric fuels used for space heating and cooking.
- Peak tourist season offers energy management challenges. LPG use for cooking may be encouraged in the tourism sector to decrease electricity peak load demand.

ENERGY DATA OVERVIEW: OVERBERG

Introduction

The Overberg District located in the south of the Western Cape and bounded by the Indian and Atlantic Oceans to the south, and Cape Town, Cape Winelands and Eden in the west, north and east, comprises 4 local municipalities: Cape Agulhas, Overstrand, Theewaterskloof and Swellendam. The District covers an area of over 11,391km^2 with a population of 212 782, constituting the Western Cape's second smallest population (4%).

Major economic activities taking place in this region include: 1) agriculture, fishing and forestry accounting for 21.1% of the district GDP and is the biggest employment contributor (21.3%), 2) manufacturing contributing 16.3% of district GDP; 3) wholesale and retail trade, catering and accommodation accounting 13.7% of district GDP, and 4) finance, insurance, real estate and business services contributing 25.1% of district GDP.

In terms of the level of development in the district, poverty has been on the rise since 1996, with 29.6% households currently living in poverty. Unemployment stands at 18%, with Overstrand and Theewaterskloof accounting for the highest share of unemployed. In terms of housing provision, 87.9.5% households reside in formal dwellings, while 10.5% live in informal dwellings. With regard to energy service provision, 94.1% of all households have access to electricity.[22]

The energy picture

Table 28: Key sustainable energy indicators in Overberg

Key sustainable energy indicator	Unit of measure	District Value 2009	Provincial Value 2009	National Value 2009*
Energy consumption per capita	GJ/capita	32	64	53
GHG emissions per capita	tCO_2e/capita	5.1	8.0	7.7
Energy per GDP (R' mill)	GJ/GDP	988	1,428	1,094
GHG emissions per GDP(R' mill)	tCO_2e/GDP	157	178	159

*Source: Department of Energy: South African Energy Synopsis 2010: data for 2006 only/SA's 2nd National Communication, 2011, data for 2000 only

The Overberg district accounts for only 2% of the provincial energy total; and 3% of GHG emissions. As a predominantly rural/agricultural area, with a couple of larger towns, Overberg has lower energy consumption, and related GHG emissions, per capita than the provincial and national average. In terms of energy intensity (the amount of energy to produce a unit of economic value) it is on a par with the national average, although it remains lower than the provincial average.

[22] Overberg District Municipality IDP, 2012-2016

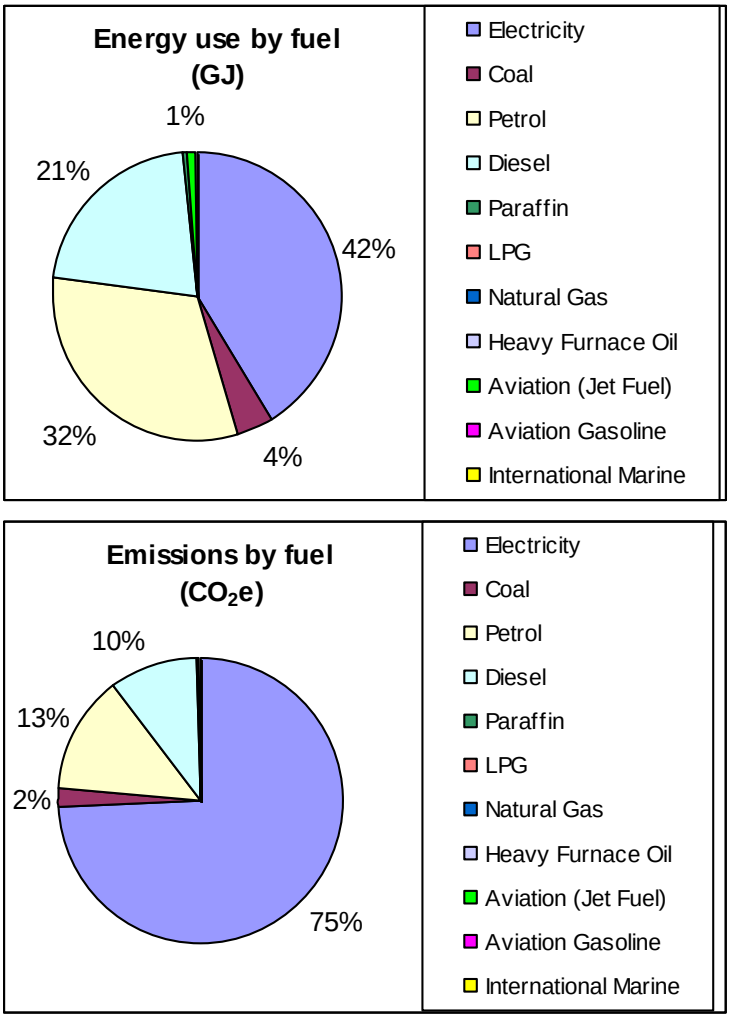


Figure 34: Energy use and energy-related emissions by fuel type in Overberg

Fossil fuels dominate the mix, accounting for nearly 100% of the energy sources (5% of electricity is sourced from nuclear energy in the national mix). There is a fair bit of household consumption of fire wood, but use of this fuel is difficult to quantify and is used in such small amounts (from an energy perspective) unlikely to be visible in the district energy picture. Dependence of fossil fuels renders the district vulnerable to price increases and shocks, supply disruptions and possible costs associated with carbon pricing in the future.

Transport fuels (petrol and diesel) account for half of the energy consumed in the district; with electricity (42%) and coal (4%) consuming the bulk of the remainder. Although only 42% of energy consumed, electricity accounts for 75% of GHG emissions (the highest proportion of electricity-caused emissions of all districts). This is due to it having a high emissions factor resulting from its source in low grade, 'dirty' coal.

Coal, according to Air Quality data, is used in the district for boilers (unspecified) and 'animal matter reduction' - likely some form of agri-processing.

Sustainable energy approaches to meeting energy demand is almost insignificant. Overstrand Municipality noted that 411 solar water heaters have been installed in low income households (however, this is a 2010 installation); some SWHs have been installed in Barrydale (Swellendam Municipality), but no figures were provided; and Theewaterskloof Municipality noted some 30 SWHs have been installed in the mid-high income household sector.

Energy efficiency initiatives include geyser blankets and geyser load control units in two of the municipalities. Swellendam Municipality has brought down electricity losses from some 9-6% between 2008 and 2011. One municipality noted that it undertakes electricity savings awareness.

Sector Disaggregation

As illustrated in the figure below, the transport sector dominates in terms of energy use, but again, when it comes to emissions the electricity consuming sectors (notably those relating to the built environment: residential and commercial) emerge as equal. In the Overberg all sectors contribute very equally to the overall GHG emissions. However, when agglomerated, the built environment is probably the most important sector to manage in respect of carbon emissions. It is likely that a large amount of the transport fuels and associated with long distance travel, with the N2 running through towns such as Caledon and Swellendam. This means that this sector is difficult to manage, with much of the responsibility lying in provincial and national spheres.

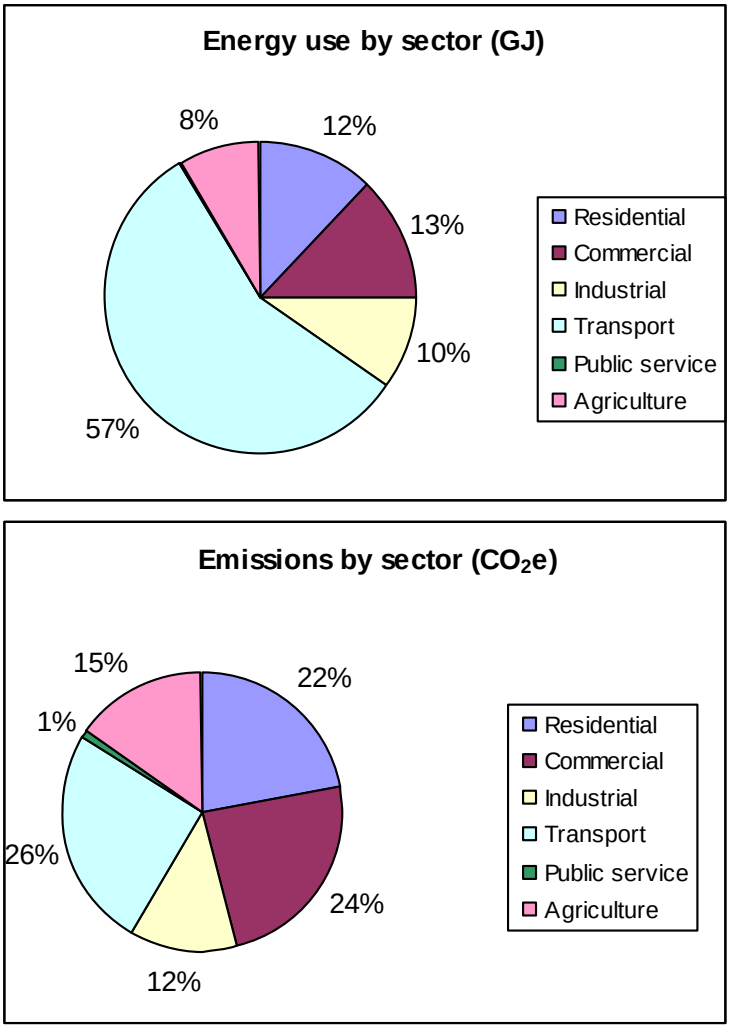


Figure 35: Energy use and energy-related emissions by sector in Overberg

Given that electricity production and consumption is a high contributor to GHG emissions and the fact that the local built environment contributes some 46% to the district emissions, this is an important sector to understand. The residential and commercial sectors combined contribute 64% of consumption (31 and 33% respectively), with agriculture contributing 21% and industry 14%. This means that there is likely to be substantial opportunity within the built environment for realising energy efficiencies. It would also be worth understanding the use of electricity within agriculture and industry in order to evaluate the efficiency potential of these sectors.

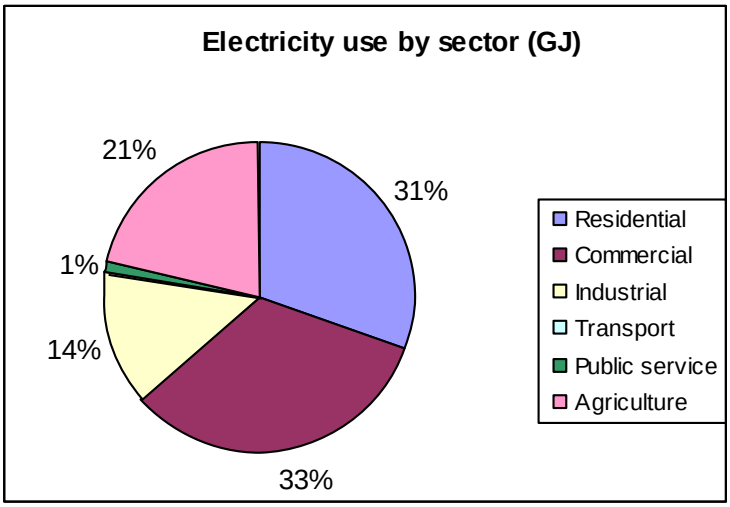


Figure 36: Electricity use by sector in Overberg

Residential Sector

National statistics on household energy consumption for the district indicate that use of electricity for lighting in the district stands at some 90%. Lighting provides a good proxy for level of electrification; and this figure is strong against a national average of 82% electrified. The district figures for electrification backlog stand at:

Table 29: Electrification backlog in Overberg

Municipality	Projected total households 2009 (with 1 % growth)	Backlog (no growth)	Backlog (1% household growth)	Backlog according to municipal own data
Theewaterskloof	25 706	3 637	5 362	600
Overstrand	20 805	1 246	2 642	2000 (informal – but a 2012 est)
Cape Agulhas	8 276	465	1 020	250 formal; 804 informal
Swellendam	8 354	7	567	none
District total		**5 373**	**9 612**	

Source: National Department of Energy, 2009, and Municipal Questionnaires (SEA, 2012)

Table 30: Free Basic Electrification Grant in Overberg

Municipality	Households receiving FBE grant
Theewaterskloof	5911
Overstrand	2615
Cape Agulhas	7412
Swellendam	1475
District total	**17413**

Source: Municipal Questionnaires (SEA, 2012)

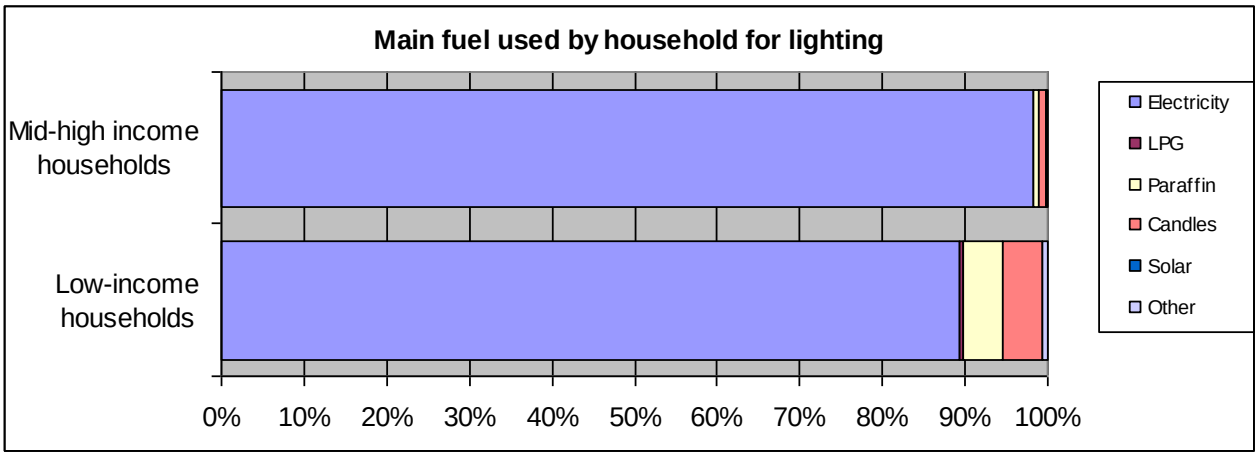
It would be useful to track the proportion of households qualifying for an electricity subsidy over the total number of households, over time. This would provide some idea of whether this is growing relative to total consumption.

In the instance of lighting, the 10% of non-electrified households are using a combination of candles and paraffin lamps for lighting. Even where electrification is in place, many poorer households continue to use a mix of fuels, with substantial paraffin for cooking (and limited gas) and paraffin and wood for space heating. The consumption of wood for household space heating, at around 10% is high.

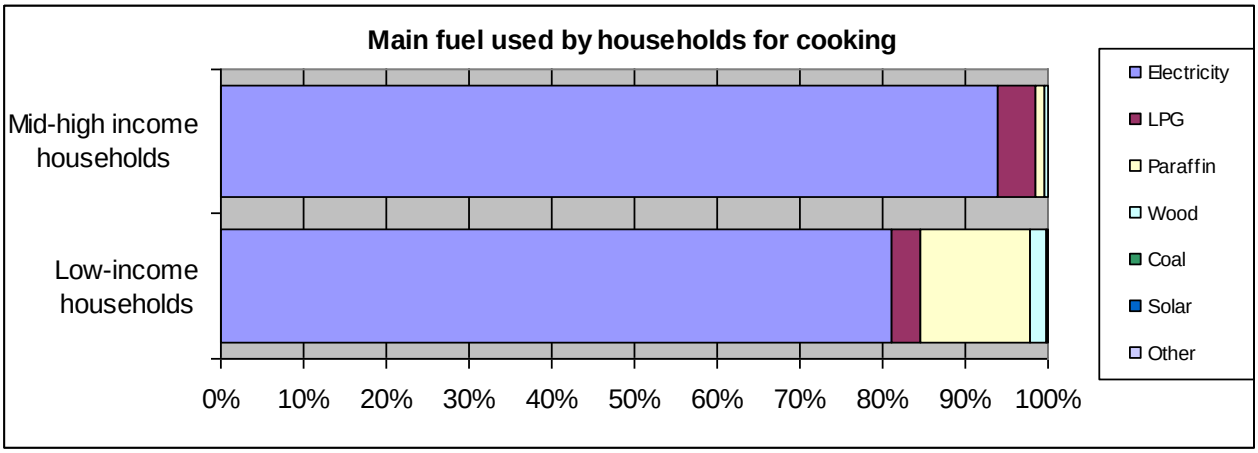
This persistent use of non-electrical sources of energy indicates high levels of poverty and represents a vulnerability to disaster incidences associated with these fuels: burns, fires, and respiratory illness.

In mid- to high-income households, LPG is used to some extent in cooking and space heating (alongside some wood usage). Indoor wood consumption is not an issue where there is adequate chimney function and good ventilation.

In comparison with other district municipalities, the Overberg District is roughly in the middle of the range when it comes to the level of electrification and the percentage of electricity used for space heating and cooking.



*Can be used as a proxy for electrification



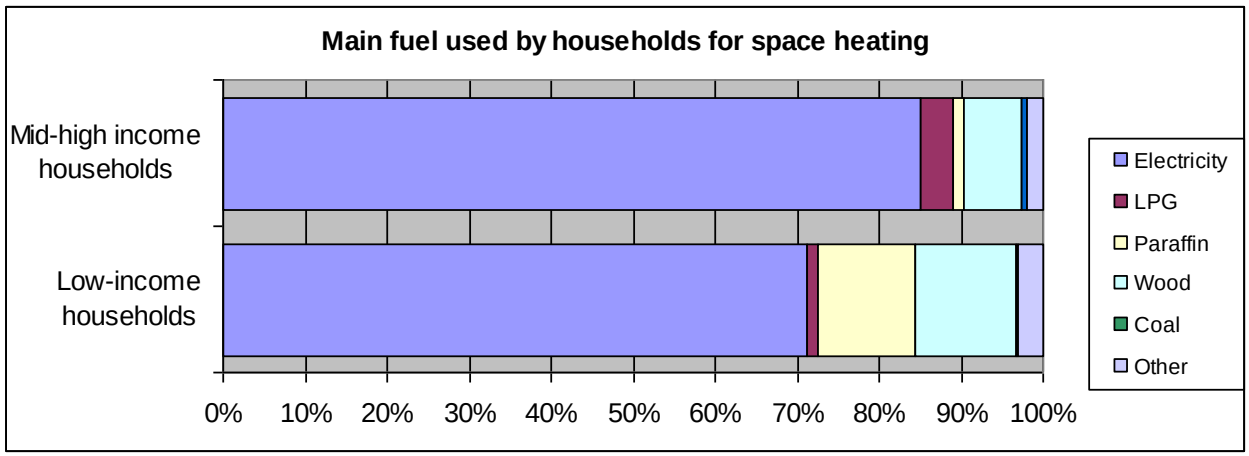


Figure 37: Fuel used by households for lighting, cooking and heating in Overberg

Commerce and Industry

Agriculture, industry and commerce are all important energy consumers in the district, although overall contribution by the district to provincial GVA and energy consumption is relatively small. As noted above, the built environment in which these activities takes place can offer energy efficiency potential.

When examining the top ten electricity users (for those municipalities that provided this information), the following stand out:

- the public sector is a notable electricity consumer; this includes prisons, hospitals and parastatal companies, such as Telkom;
- small agro industries, such as agricultural feed producers, dairies and abattoirs represent the industrial component, of top electricity consumption;
- tourism – hotels, spas and casinos;
- retail – shopping centres.

While there may be some industrial process efficiencies to be gained within the smaller, agro-industries, the other large consumers consumption largely relates to built environment.

Transport

Given the lack of detailed transport data, there is no modal split for the province at this stage. This could be worked on through establishing estimated passenger kilometres and relating this to fuel consumption. However, with the lack of data on the transport characterisation of towns along national roads, small towns versus larger metros, etc, this was felt to be premature. Data has been gathered on vehicle ownership and the growth of this can be tracked over time.

Table 31: Vehicle population in Overberg

Vehicle type	Cape Winelands	Central Karoo	Eden	Overberg	West Coast	Cape Town
Public	3 953	198	3 125	1 273	1 596	28 943
Private	105 044	5 569	101 226	41 321	48 756	787 434
Other	12 134	462	7 709	5 411	9 785	14 800
Freight	63 072	4 848	59 463	28 373	40 863	247 712
Vehicles per capita (2011)	**0.24**	**0.22**	**0.31**	**0.36**	**0.36**	**0.27**

The Overberg District, along with West Coast District, has the highest level of vehicle ownership.

Local Government

Although local government only consumes around 1% of total energy consumption in the district, it has an important role to play as it is one of the single largest consumers in each municipality. It can also lead by example in sustainable energy drives. Within local government consumption, the breakdown between sectors is as follows:

Table 32: Local government energy use by service in Overberg

Local govt energy use by service	GJ
Buildings & Faclities	9 605
Water & Waste Water Treatment	0
Street and Traffic Lights	1 586
Vehicle Fleet	5 691

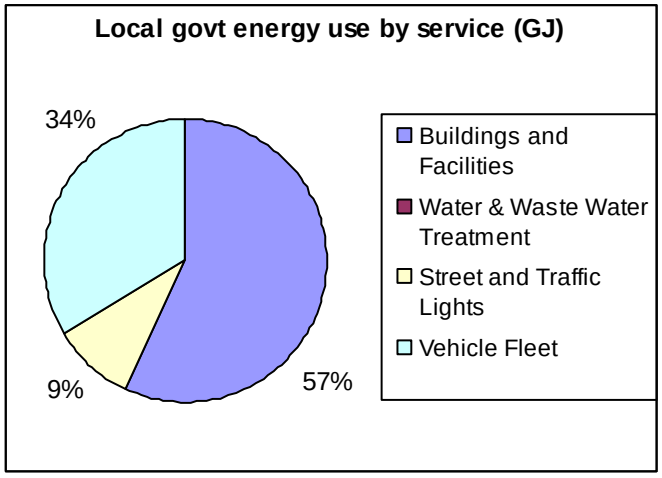


Figure 38: Local government energy use by service sector in Overberg

Both public buildings and vehicle fleet management appear to offer important opportunities in energy savings, but it should be noted that the above graph must be approached with caution. Data was not captured for 2 local municipalities in the district, the electricity use of buildings and waste water treatment was combined in one municipality's figures, and the last municipality did not have figures for buildings and vehicle fleet energy consumption. This area would require further investigation.

Waste figures are not very clear at this stage. The average waste per capita in the district for 2009 was 0.33 tonnes per annum. Waste contributes significantly to global warming emissions and managing this sector to reduce these is an important response in mitigating climate change.

All municipalities in the district appear to have around 18-20 full time engineers in their Electricity departments and a variety of part-time staff who are able to engage in electricity saving, climate change and other initiatives. These roles are not part of any specific job description and apart from running electricity savings awareness in one municipality, no municipalities in the district have policies addressing the sustainable energy or climate policy goals of the Western Cape Government.

Conclusion

While the energy consumption in this district is small and it represents a very small part of the total provincial consumption, important saving opportunities exist within the built environment. These could target large retail outlets and provincial and local government.

Key Issues

- There may be opportunities to pursue the use of LPG for cooking in the residential sector, so as to decrease peak electricity demand.
- Energy poverty is highlighted through the use of multiple fuels for cooking and space heating even when a household is electrified. Overberg is roughly in the middle of the range where electrification and energy poverty are concerned when compared to other district municipalities.
- The Overberg District (together with the Cape Town metro) has the highest amount of per capita vehicle ownership. Public transport may be investigated as a sustainable energy option.
- Minimal data was available on local government energy use.
- Electricity use contributes to the bulk (75%) of GHG emissions in the district. The residential and commercial sectors (contributing 64% to electricity consumption) are important where electricity efficiency and a decrease of emissions is concerned.

ENERGY DATA OVERVIEW: WEST COAST

Introduction

The West Coast District, located to the north of the City of Cape Town and bounded by the Atlantic Ocean in the West and the Cederberg mountain ranges in the east is made up of 5 local municipalities: Matzikama (in the North), Cederberg (in the centre), Bergriver, Saldanha Bay and Swartland in the South. The District covers an area of 31,124 km^2 and accommodates a population of 286,746 people, accounting for 5.4% of the Western Cape's total population. All 5 municipalities have access to the Atlantic Ocean. The N7 (national road) connects all the municipalities in the district with the exception of Saldanha Bay.[23]

Major economic activities taking place in this region include: 1) finance, insurance, real estate and business services contributing 24% to regional GDP; 2) manufacturing contributing 18% to regional GDP, 3) agriculture, hunting, forestry and fishing contributing 15% to GDP and 4) tourism (West Coast District IDP 2012-2016). The West Coast district serves as a strong regional development corridor linking the City of Cape Town metropolitan with the economies of Namibia and Angola. In addition the District presents enormous potential in the areas tourism, oil and gas, aquaculture and alternative energy (wind, wave and solar).

In terms of the level of development, in 2010, 30% of the district's population was reported to be living in poverty comprising 14,394 indigent households. Further the Gini coefficient, a measure of income inequality (with 0 being a case of perfect equality where all households earn an equal income and 1 being where one household earns all the income and other households earn nothing), remains high at 0.65 in 2010. The Human Development Index (HDI), a measure of life expectancy, literacy and income however measures in at 0.65, revealing a relatively favourable level of human development. Saldanha Bay Municipality, relative to other municipalities in the district, has displayed the highest levels of education levels, social infrastructure and lowest poverty levels, emerging as the most developed municipality within the district recording HDI indicators of 0.67 and 0.69 in 2001 and 2007 respectively.

Unemployment in 2007 stood at 15.5%. Major sectors contributing to employment include community social and personal services (12.9%), manufacturing (12.3%), agriculture, hunting, forestry and fishing (27.9%). In terms of access to housing, in 2007, 93% of households resided in formal dwellings, while only 5.2% lived in informal dwellings.[24]

The energy picture

Table 33: Key sustainable energy indicators in West Coast

Key sustainable energy indicator	Unit of measure	District Value 2009	Provincial Value 2009	National Value 2009*
Energy consumption per capita	GJ/capita	298	64	53
GHG emissions per capita	tCO_2e/capita	32.2	8.0	7.7
Energy per GDP (R' mill)	GJ/GDP	8 955	1,428	1,094
GHG emissions per GDP(R' mill)	tCO_2e/GDP	967	178	159

*Source: Department of Energy: South African Energy Synopsis 2010: data for 2006 only/SA's 2nd National Communication, 2011, data for 2000 only

The energy intensity (i.e. the amount of energy consumed per unit of economic production) of the West Coast District far surpasses that of the Western Cape Province and the entire country, by an order of magnitude of six and eight times respectively. Similarly the district's energy consumption per capita displays an order of magnitude five times that of province and national values. This large energy intensity from both an economic and per capita basis can be accounted for by the energy intensive industries in the district.

[23] West Coast District IDP 2012-2016
[24] West Coast District IDP 2012-2016

Coal use by the industrial sector accounts for 77% of total fuel use in the West Coast District. It is used in the iron, steel, sand, cement and lime industries on the West Coast, which utilise coal as their primary feedstock for industrial activities.

It is apparent that this high level of energy consumed for economic value generated has given rise to substantial human and social development particularly within Saldanha Bay municipality, where this industrial activity is located, showing the highest levels of education and social infrastructure and lowest levels of poverty in the region.

In terms of carbon intensity, the district exhibits the highest levels of GHG emissions related to the energy consumption per unit of economic value generated, far exceeding the provincial and national total by a factor of five and six respectively. Similarly, the GHG emissions of 32.2 tonnes per person, is not only the highest for the district, but four times higher than the provincial and national average and thirty tree times that of the entire continent. Again, this remarkably high carbon intensity can be exclusively attributed to the intensive industrial activities in the district.

The energy consumption and carbon emissions of the West Coast District account for approximately 25% of the provincial total. This is largely caused by the intensive industrial activity in the area. It is important to note that West Coast would likely have had a similar energy consumption and carbon emissions profile relative to other districts in the province were it not for the fact of the heavy energy intensive steel industrial activity in the district.

As is evident from the figure below, the district remains heavily dependent on fossil fuels, dominated by particularly coal use. This very low level of fuel diversification on which the economic production of the region depends presents a potential serious threat to its future economic production and well-being.

Although only 14% of energy consumed, electricity accounts for 36% of GHG emissions. This is due to it having a high emissions factor resulting from its source in low grade, 'dirty' coal. Though coal is a largest contributor towards emissions, this is not to say that coal use is undesirable. If electricity (which is coal-fired) was used for the same purposes, instead of coal (directly), the carbon footprint would have been even higher. In this case, a high carbon footprint is not as much related to the type of fossil fuel, but to the scale of industrial activity.

The West Coast has started to show signs of addressing the challenges posed by the need for energy diversity, energy efficiency and decreasing GHG emissions and increasing use of renewable. Major plans are afoot for the establishment of wind energy farms in the West Coast and energy efficiency programmes have taken place through geyser load control interventions and the mass rollout of efficient 'Wonderbags' to support energy efficient cooking and reduce energy poverty. Industries themselves have implemented major efficiency measures.

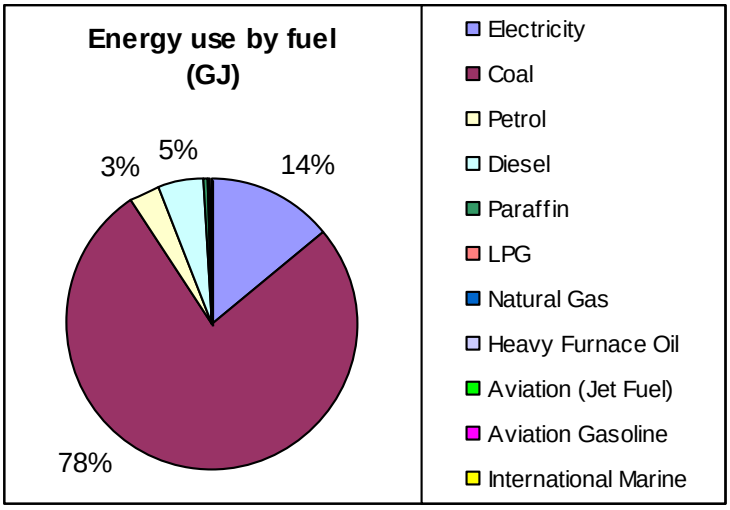


Figure 39: West Coast District energy consumption by fuel type, 2009

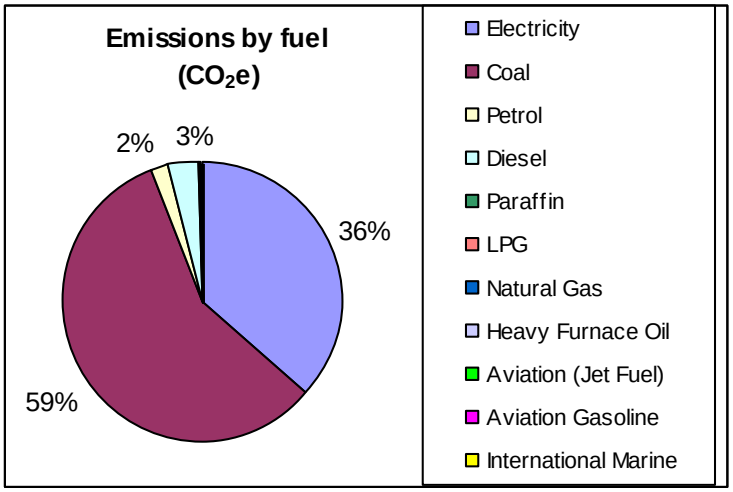
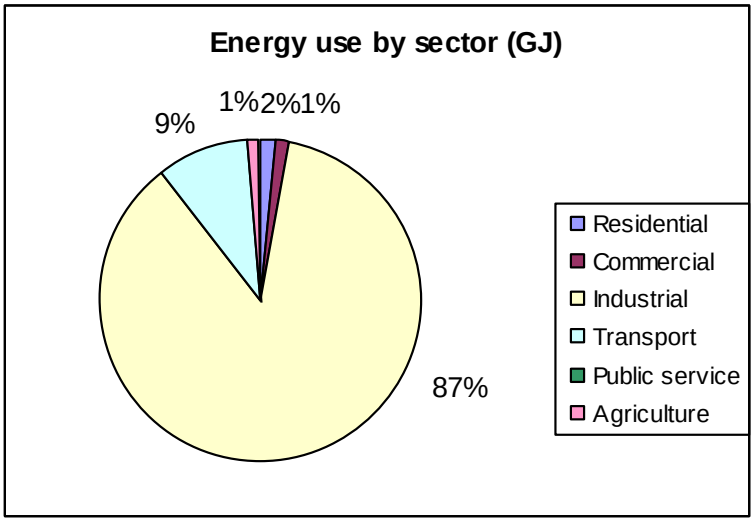


Figure 40: West Coast District energy-related emissions by fuel type, 2009

Sector Disaggregation

The pie charts below illustrate the distribution of energy use and carbon emissions across sectors in the region. The industrial sector dominates the energy picture accounting for huge proportion (87%) of the energy consumed in the district. This is attributed to the heavy energy intensive industrial activity. Similarly the industrial sector stands out as the major carbon emitting sector in the district given the intensive use of coal and electricity by the industrial sector.



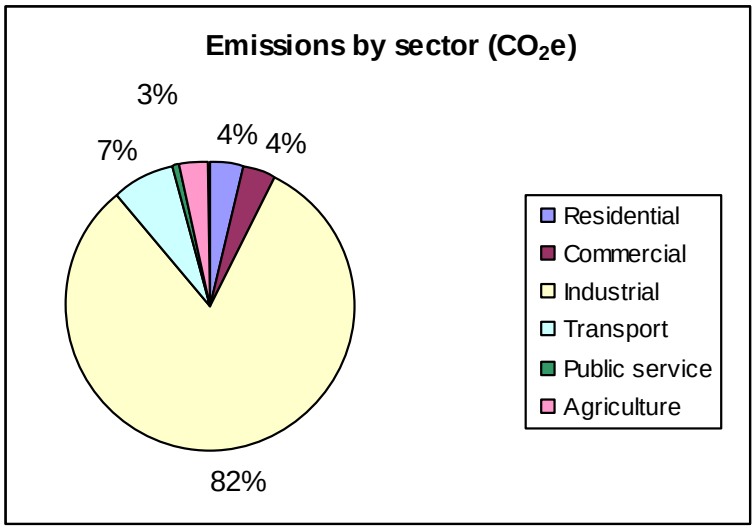


Figure 41: Energy consumption and energy-related emissions by sector in the West Coast

Given the importance of electricity in GHG emissions, this is an important sector to understand. Visible in the figure below, the industrial sector contributes to 65% of electricity consumption. The residential, commercial and agriculture sectors all contribute 10% each. There is likely substantially opportunity within these sectors for realising energy efficiencies. It would also be worth understanding the use of electricity within these sectors in order to evaluate the efficiency potential of these sectors.

Understanding sectoral contributions to energy and carbon emissions enables effective energy management. It assist in identifying the sectors in the municipalities/districts that will be affected by development costs related to energy supply and energy use and, to this end, enables targeted policy development.

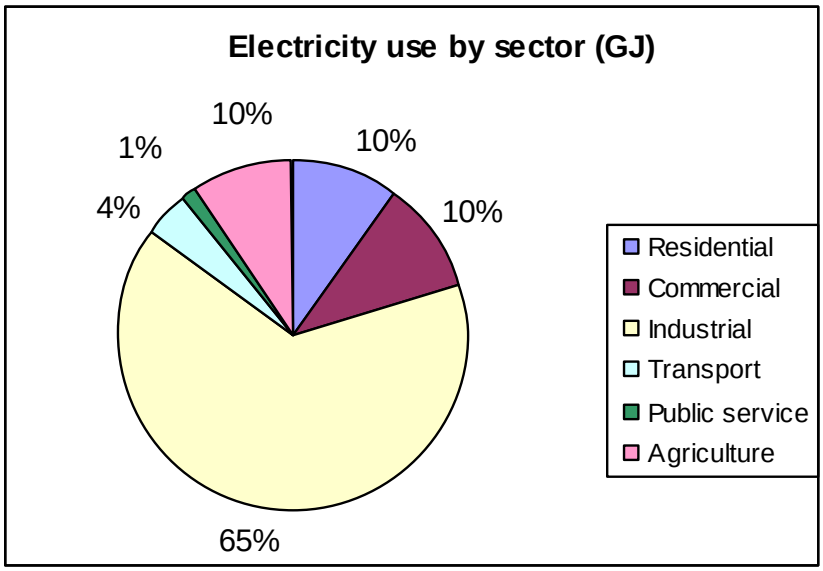
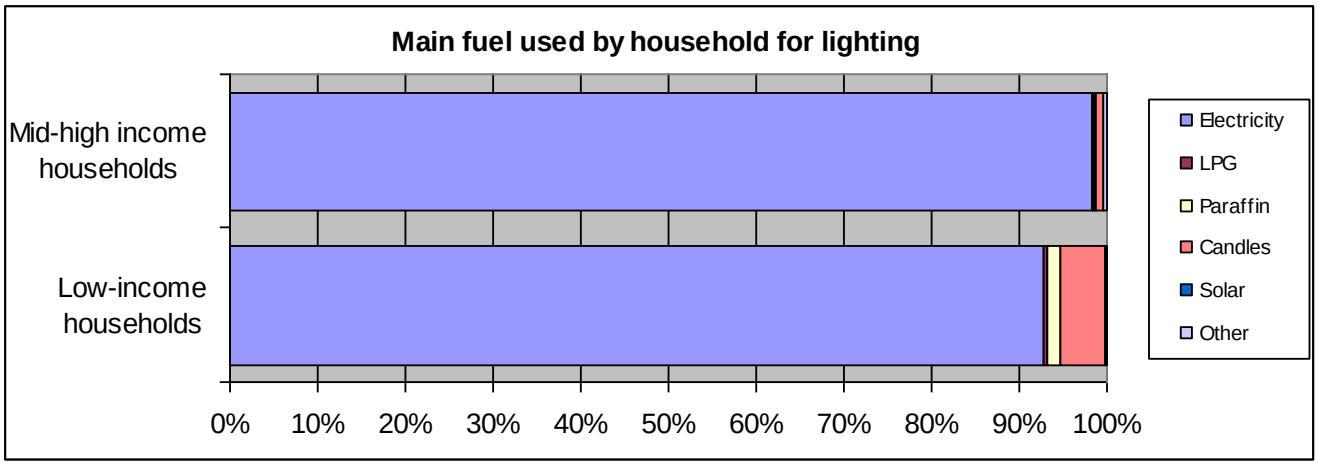


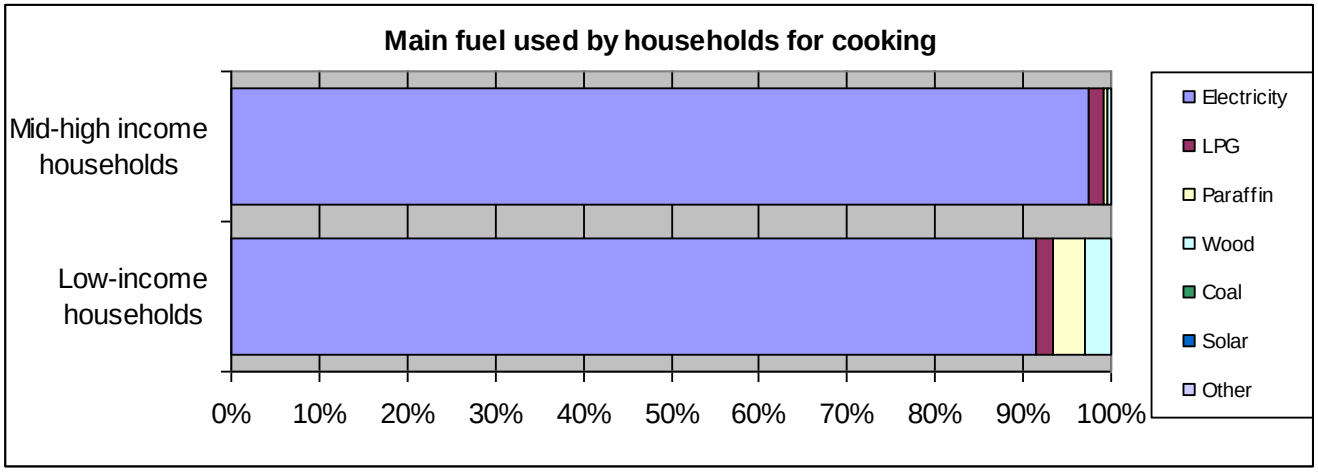
Figure 42: West Coast electricity use by sector, 2009

Residential Sector

The majority of the district is electrified, while the remaining amount of 5,500 households are awaiting electrification. The graphs below illustrate the household fuel mix by mid-high and low-income households in meeting main household energy needs, notably lighting, cooking and space heating. Lighting provides a good proxy for level of electrification; and this figure is strong against a national average of 82% electrified. Energy poverty is usually indicated through a larger proportion of non-electricity fuels used for space heating and cooking than the proportion of unelectrified households, i.e. households that may have access to electricity are not using it due to its high cost. The West Coast District displays the highest level of electrification and the lowest level of energy poverty when compared with the other districts. This indicates that the large industrial activity has added substantially to the area's development.



*Can be used as proxy for electrification



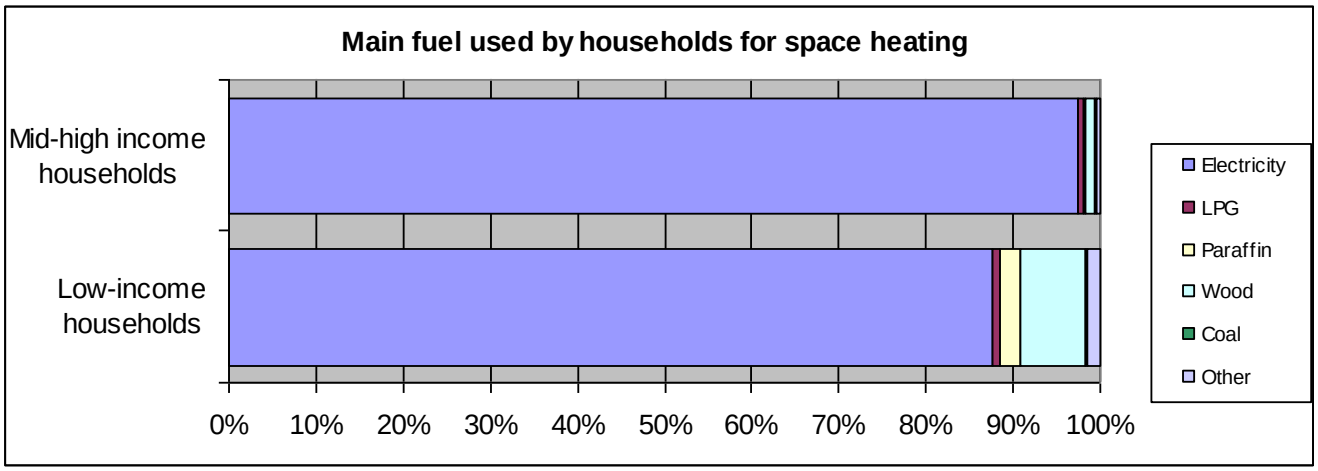


Figure 43: Fuels used for lighting, cooking and space heating in West Coast, 2009.

Table 34: Free Basic Electrification Grant in West Coast

Municipality	Households receiving FBE grant
Bergriver	10,510
Cederberg	733
Matzikama	1,700
Saldanha Bay	4,791
Swartland	4,116
District total	**21 850**

Source: Municipal Questionnaires (SEA, 2012)

It would be useful to track the proportion of households qualifying for an electricity subsidy over the total number of households, over time. This would provide some idea of whether this is growing relative to total consumption.

Commerce and Industry

The industrial sector's electricity and energy use dwarfs that of other sectors. The commercial sectors energy and electricity use is on par with that of the residential and agriculture sectors. Some of the district's top 10 municipal-distributed electricity users include retail, parastatal, government, banks and abattoirs.

Transport

Given the paucity of detailed transport data, there is there is no modal split for the province at this stage. This could be worked on through establishing estimated passenger kilometres and relating this to fuel consumption. However, with the lack of data on the transport characterisation of towns along national roads, small towns versus larger metros, etc, this was felt to be premature. Data has been gathered on vehicle ownership and the growth of this can be tracked over time.

Table 35: Vehicle population in West Coast

Vehicle type	Cape Winelands	Central Karoo	Eden	Overberg	West Coast	Cape Town
Public	3 953	198	3 125	1 273	1 596	28 943
Private	105 044	5 569	101 226	41 321	48 756	787 434
Other	12 134	462	7 709	5 411	9 785	14 800
Freight	63 072	4 848	59 463	28 373	40 863	247 712
Vehicles per capita (2011)	**0.24**	**0.22**	**0.31**	**0.36**	**0.36**	**0.27**

The high vehicle ownership is possibly due to the economic wealth generated in the West Coast by the large industrial activities.

Local Government

Although local government only consumes around 1% of total energy consumption in the district, it has an important role to play as it is one of the single largest consumers in each municipality. It can also lead by example in sustainable energy drives such as building and operations efficiency and vehicle fleet management – offer important opportunities for financial and energy savings. Within local government consumption, the breakdown between sectors is as follows:

Table 36: Local government energy use by service in West Coast

Local govt energy use by service	GJ
Buildings & Faclities	7 857
Water & Waste Water Treatment	71 213
Street and Traffic Lights	45 903
Vehicle Fleet	50 734

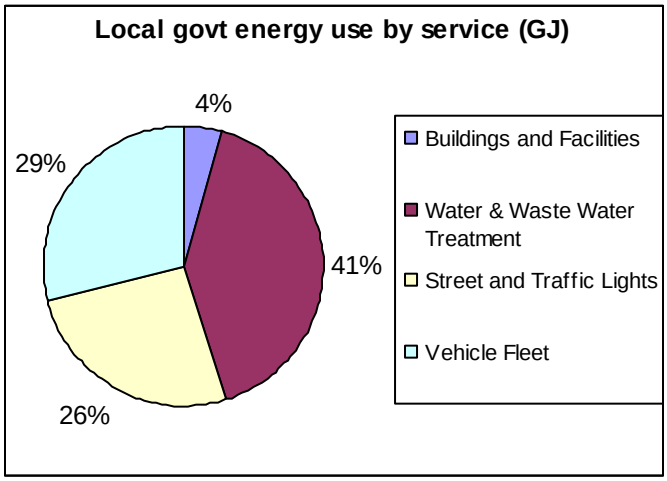


Figure 44: Local authority energy consumption in West Coast, 2009

The above figure should be approached with caution, as complete data was only available for one local municipality. Two other local municipalities could supply data on energy use for all but the vehicle fleet. It appears that a large proportion of energy is used in operations when compared to other districts, which indicate higher energy use in buildings and facilities. It would be worth exploring this further, e.g. does the pumping of water in the Berg River add a large energy cost?

Waste figures are not very clear at this stage. The average waste per capita in the district for 2009 was 0.26 tonnes per annum. Waste contributes significantly to global warming emissions and managing this sector to reduce these is a very important response in mitigating climate change.

All municipalities in the district appear to have around 12–30 full time engineers (with the exception of Saldanha Bay Municipality which has 58 full time staff) in their Electricity departments and a variety of part-time staff. However, no staff are engaged in electricity savings, climate change and other initiatives. These roles are not part of any specific job description. No municipalities in the district have policy addressing the sustainable energy or climate policy goals of the Province.

Conclusion

The energy consumption in this district is the highest in the province, and represents 25% of the total provincial consumption, highlighting important saving opportunities particularly within the industrial sector. These could target industrial activities in the District. Given that heavy industry dominates the energy and carbon footprint of the district, policies or measures to encourage or assist these industries to improve energy efficiency should be put in place.

Key Issues

- The district displays high levels of electrification and low levels of energy poverty due to economic contribution of the large industrial activities in the area.
- The energy intensity (i.e. the amount of energy consumed per unit of economic production) of the West Coast District far surpasses that of the Western Cape Province and the entire country, by an order of magnitude of six and eight times respectively. Similarly the district's energy consumption per capita displays an order of magnitude five times that of province and national values. The GHG emissions of 32.2 tonnes per person, is not only the highest for the district, but four times higher than the provincial and national average and thirty tree times that of the entire continent. This large energy and emissions intensity can be accounted for by the energy intensive industries in the district.
- The district remains heavily dependent on fossil fuels, dominated by coal use (77%). This very low level of fuel diversification on which the economic production of the region depends presents a potential serious threat to its future economic production and well-being. The industrial sector would be vulnerable to fuel costs, e.g. carbon pricing, escalating electricity costs.
- Although only 14% of energy consumed, electricity accounts for 36% of GHG emissions. This is due to it having a high emissions factor resulting from its source in low grade, 'dirty' coal.

Summary of Results

In 2009, community-wide energy- and waste-related greenhouse gas (GHG) emissions in the Western Cape Province totalled 44,261,200 tCO_2e metric tonnes of CO_2e or approximately 8.4 tonnes per capita based on 2009 population figures. The per capita rate of emissions provides a sense of how the Western Cape's GHG emissions compare with other communities or countries. Compared to South Africa's 2011 per capita average of 9.3 tonnes CO_2e, the Western Cape's figure is slightly lower. Electricity is by far the largest source of GHG emissions in the province accounting for 53% (21,891,661 metric tonnes CO_2e).

Study Scope

The inventory process considered the following greenhouse gases (GHGs): carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O). The greenhouse gas emissions attributed to energy and solid waste management tracked in this analysis were all converted to their carbon dioxide equivalent (CO_2e) emissions. Global Warming Potentials (GWP) of each of these gases was used in this conversion which indicates the relative contribution of each gas to global average relative forcing. The idea is to report all the greenhouse gases as though they were equivalent to a given volume of CO_2. CO_2 as the reference gas has a GWP of 1. Conversion of other GHGs into CO_2 equivalents was done according to the IPCC requirements as listed below:

Table 37: Emissions conversion factors

Greenhouse Gas	Chemical Formula	IPCC GWP
Carbon dioxide	CO_2	1
Methane	CH_4	21
Nitrous Oxide	N_2O	310

Part of the reasoning for focusing on energy and solid waste emissions is that, in the bigger picture, fossil fuel related CO_2 and solid waste related CH_4 comprise the vast majority of the country's climate change inducing emissions, with the other greenhouse gases contributing marginally to the overall inventory. Note that the inventory does not include HFC, SF_6 and PFC emissions. Additionally, the inventory does not include emissions related to the production of most goods bought or consumed in the province (embedded emissions).

Methodology

The methodology for this inventory is based on the Global Protocol for Community-Scale GHG Emissions (GPC) released by C40, ICLEI and WRI with support from the UNHABITAT, UNEP and the World Bank. The idea is to keep with an approach that other local government authorities will use for their greenhouse gas inventories.

The primary basis for this inventory is the electricity sales figures, liquid fuel and natural gas consumption statistics and solid waste generation figures for each municipality analysed. These sources were disaggregated per municipality and at a district level. Baseline year data (set at 2009) was acquired from a wide range of sources.

Emission factors

Energy emissions from all sources of combustion were estimated using the Tier 1 Method where CO_2 emissions from fuel combustions are estimated by multiplying the amount of fuel used (taken from national/municipal statistics) with a fuel-specific default CO_2 emission factor (EF). It is important to note that South Africa hasn't developed its own country-specific emission factors for a number of emission sources. We recognise the fact that this method although accurate for CO_2 emissions is however less accurate for non-CO_2 gases because emission factors for these gases may depend considerably on the combustion technology and operating conditions.

Community scale emissions

Emission sources and sector categorisation in this analysis were done so as to align with the GPC which takes into account the unique nature of communities (municipalities) and their primary emission sources. These sectors include emissions from 1) Stationary units, 2) Mobile Units, 3) Waste, not included in this assessment are emissions from the Industrial Process and Product Use (IPPU) sector. In light of the resource and data constraints, it was decided not to include emissions from agriculture, forestry and land-use (AFOLU) which are among the most complex categories for GHG accounting. This study focuses on energy-use-related emissions as well as solid waste emissions. Sectors analysed here consist of the following sub-sectors (see table below).

Table 38: Greenhouse gas emissions sector categories

Sector	Sub-Sector
STATIONARY UNITS	Residential sector
	Commercial
	Agriculture Energy Use
	Industrial Energy Use
	Municipal Operations
MOBILE UNITS	On-road transportation
	Railways
	Water-borne navigation (Marine)
	Aviation
WASTE	Solid Waste Disposal

Emissions were categorised into 3 different Scopes, indicated below, in line with the draft Global Protocol for Community-Scale GHG emissions (GPC).

- Scope 1: all direct emission sources from activities taking place within a municipality's geopolitical boundary.
- Scope 2: energy-related indirect emissions that result as a consequence of consumption of grid-supplied electricity within the municipality's geopolitical boundary.
- Scope 3: all other indirect emissions that occur as a result of activities within the municipality's geopolitical boundary. Embodied emissions aren't included in this inventory.

Outlined below are the emission sources included in this inventory listed according to their respective Scope categories.

Table 39: GHG emissions sources included in greenhouse gas inventory

Scope 1 – Direct emissions	Scope 2 – Indirect emissions	Scope 3 – Indirect emissions
Mobile fuel combustion Stationery fuel consumption Solid waste disposal	Electricity consumption	Air transport Marine transportation

Results

Inventory Sheet 1: Community emissions by Sector per Municipality in the Western Cape Province

Table 40: Community GHG emissions by sector per municipality in the Western Cape Province

Community Emissions by Sector per Municipality (tCO_2e) excl. Eskom electricity supply to individual municipalities and coal data which are only available at a district level								
Sector	**Stationary**					**Mobile Units**	**Waste**	**Total Emissions (tCO_2e)**
Sub-sector	**Agriculture**	**Commercial**	**Minicipal Operations**	**Industrial**	**Residential**	**Transportation**	**Solid Waste**	
Beaufort-West	-	-	12 836	20 746	69 379	148 069	33 164	284 193
Berg River	57	25 282	11 411	13 567	37 864	52 313	6 527	147 022
Bitou	-	45 389	19 835	-	45 377	65 222	1 639	177 461
Breede Valley	-	48 179	19 646	160 676	101 816	116 522	-	446 839
Cape Agulhas	464	8 837	11 897	11	46 060	25 586	7 071	99 925
Cederberg	358	10 215	10 201	9 355	29855	47 724	27 043	134 752
City of Cape Town	175 276	2 431 271	254 947	5 574 043	5 270 182	9 954 942	1 360 214	25 020 875
Drakenstein	111 831	271 173	98 785	34 657	242 013	221 892	189 153	1 169 504
George	3 090	50 309	36 893	188 087	205 390	165 673	35 897	685 339
Hessequa	2 791	15 476	20 498	-	477 239	57 909	23 932	168 331
Kannaland	-	6 686	7 960	47 495	18 743	18 207	0	99 091
Knysna	-	66 479	44 417	-	85 938	65 222	68 864	330 920
Laingsburg	-	2 734	2 749	-	1 656	30 624	0	37 762
Langeberg	52 273	16 824	36 639	136 919	57 504	46 837	33 939	380 936
Matzikama	-	26 505	10 214	-	31 269	68 764	0	136 752
Mossel Bay	275	40 372	27 263	155 500	176 597	242 620	32 080	674 707
Oudtshoorn	2 461	51 610	32 161	8 575	77 409	77 973	0	250 189
Overstrand	-	89 695	65 790	21	73 123	90 438	43 947	363 014
Prince Albert	-	-	-	-	11	11 509	0	11 521
Saldanha Bay	-	100 705	37 114	27 989	95 770	161 475	10 878	433 932
Stellenbosch	2 041	97 924	28 020	110 354	151 501	197 957	424 242	1 012 039
Swartland	26	18 443	19 104	92 361	76 824	163 586	31 882	402 227
Swellendam	-	25 759	11 419	-	10 729	23 108	0	71 014
Theewaterskloof	-	31 690	5 194	23 958	3 513	116 085	1 523	181 962
Witzenberg	12 946	16 446	17 917	96 349	44 345	85 715	16 254	289 972
Province Total	363 890	3 498 007	842 911	6 700 663	7 000 588	12 255 971	2 348 249	33 010 280

The table above presents GHG emissions per municipality by sector and sub-sector. Note that Eskom's data on electricity distribution to individual municipalities is not included in the above analysis since Eskom does not publish such information due to client confidentiality concerns and the fact that data is not collected by municipal boundaries. The same can be said about coal use data which is only available at a district-level.

Table 41: Energy- and waste-related GHG emissions by District Municipality in the Western Cape

GHG emissions by sector per district incl. Eskom electricity supply and coal use data

District Municipality	Agriculture	Commercial	Minicipal Operations	Eskom Streetlighting	Industrial	Residential	Transportation	Solid waste	Total (tCO_2e)
Cape Winelands	596 507	539 256	201 008	705	1 081 977	695 405	718 540	663 588	4,496,986
Central Karoo	5 363	8 587	15 585	102	21 390	86 699	197 082	33 164	368,245
City of Cape Town	175 276	2 431 271	231 665	23 282	5 574 043	5 270 182	9 954 942	1 360 214	25,020,875
Eden	102 982	297 875	189 027	224	1 439 109	750 344	692 826	162 412	3,634,800
Overberg	153 613	237 727	94 300	1 148	127 376	222 340	255 216	52 541	1,144,261
West Coast	310 135	333 325	88 045	591	7 807 622	344 386	635 600	76,330	9,596,033
Total GHG emissions per Sector (tCO_2e)	**1 344 150**	**3 848 042**	**819 630**	**26 051**	**16 051 517**	**7 369 355**	**12 454 205**	**2,348,249**	**44,261,200**

Inventory Sheet 2: GHG emissions from local government operations per municipality

Emissions associated with the operations of each municipality within the province were calculated. The analysis of emissions was mainly defined by an organisational boundary and encompassing functions directly under the municipality's control. Operations covered by this analysis include electricity consumption by the following; buildings and facilities, street and traffic lighting, water and wastewater treatment. Unaccounted for electricity was also included in the analysis which also includes transmission and distribution (T&D) losses. Emissions from fuel consumed by each municipality's vehicle fleet were also included. This analysis however, does not include emissions from the following: employee commuting, vehicles owned by contractors nor municipal employee air travel.

Table 42: Emissions from local government operations per municipality in the Western Cape

GHG emissions from local government operations per Municipality (tCO_2e)								
Municipality	**Buildings & Facilities**	**Streetlighting & Traffic Lighting**	**Electricity used in Water & wastewater Treatment**	**Unaccounted for electricity incl. T&D losses**	**Solid Waste**	**Government Transport**		**Total tCO2e Emissions from Munic Operations**
						Diesel	**Petrol**	
Beaufort-West	603	1 373	1 566	9 294	33 164	0	0	46 000
Berg River	2 449	0	0	8 962	6 527	0	0	17 938
Bitou	476	0	2 933	16 425	1 639	0	0	21 474
Breede Valley	1,692	2,153	4,867	10,934	0	582	436	20,664
Cape Agulhas	3 348	0	0	8 549	7 071	0	0	18 968
Cederberg	1 111	1 154	523	7 413	27 043	0	0	37 244
City of Cape Town	42 647	104 919	84 100	0	1 360 214	26 441	14 085	1 632 405
Drakenstein	15 224	6 979	0	76 582	189 153	1 607	1 027	290 573
George	2 472	15 425	18 540	455	35 897	1 440	273	74 503
Hessequa	0	1 104	1 146	18 248	23 932	0	0	44 430
Kannaland	0	0	7 960	0	0	0	0	7 960
Knysna	10 377	3 189	0	30 852	68 864	0	0	113 281
Laingsburg	24	67	237	2 420	0	0	0	2 749
Langeberg	0	4 473	8 442	23 723	33 939	600	458	71 637
Matzikama	0	0	0	10 214	0	0	0	10 214
Mossel Bay	3 554	7 899	0	15 810	32 080	0	0	59 343
Oudtshoorn	1 097	6 897	2 741	21 426	0	1 075	431	33 667
Overstrand	898	0	0	64 892	43 947	0	0	109 737
Prince Albert	0	0	0	0	0	0	0	0
Saldanha Bay	313	8 853	16 741	11 207	10 878	2 373	1 222	51 586
Stellenbosch	0	598	0	27 422	424 242	0	0	452 262
Swartland	824	3 126	3 111	12 043	31 882	0	0	50 986
Swellendam	0	454	0	10 965	0	267	136	11 822
Theewaterskloof	2 748	0	0	2 446	1 523	0	0	6 717
Witzenberg	0	2 077	0	15 840	16 254	0	0	34 171
Total GHG emissions per operation (tCO_2e)	**89 856**	**170 741**	**152,907**	**406,125**	**2,348,249**	**34,386**	**18,068**	**3,220,333**

Inventory Sheet 3: GHG emissions per municipality by Scope Type

Table 43: Municipal energy- and waste-related emissions by scope type (excl. coal use and Eskom elec supply)

Municipality	Scope 1 (tCO_2e)	Scope 1 (tCO_2e)	Scope 1 (tCO_2e)	Total (tCO_2e)
Beaufort-West	181 123	102 989	82	284 193
Berg River	59 041	87 981	-	147 022
Bitou	67 219	110 243	-	177 461
Breede Valley	119 783	326 965	91	446 839
Cape Agulhas	29 109	67 156	3 660	99 925
Cederberg	75 960	58 792	-	134 752
City of Cape Town	7 286 060	12 957 497	4 777 317	25 020 875
Drakenstein	419 899	749 575	30	1 169 504
George	180 502	482 256	22 581	685 339
Hessequa	81 841	86 490	-	168 331
Kannaland	18 207	80 884	-	99 091
Knysna	134 444	196 477	-	330 920
Laingsburg	17 012	20 750	-	37 762
Langeberg	83 866	296 912	158	380 936
Matzikama	69 068	67 684	-	136 752
Mossel Bay	356 986	314 425	3 296	674 707
Oudtshoorn	75 264	171 997	2 928	250 189
Overstrand	134 662	227 757	595	363 014
Prince Albert	11 521	-	-	11 521
Saldanha Bay	190 735	240 639	2 558	433 932
Stellenbosch	629 451	381 802	786	1 012 039
Swartland	216 102	185 725	400	402 227
Swellendam	22 916	47 741	358	71 014
Theewaterskloof	117 957	63 410	595	181 962
Witzenberg	103 467	186 466	39	289 972
Total excl. Eskom electricity & Coal use data	**10 682 194**	**17 512 613**	**4 815 474**	**33 010 280**

Table 44: District energy- and waste-related emissions by scope type (incl. coal use and Eskom elec supply)

District Municipality	Scope 1 – Total Direct GHG emissions (tCO2e)	Scope 2 – Total Indirect GHG emissions (tCO2e)	Scope 3 – Total Indirect (Air % Marine Travel) (tCO2e)	Total GHG Emissions (tCO2e)
Cape Winelands	1 793 589	2 702 291	1 105	4 496 986
Central Karoo	210 178	157 985	82	368 245
City of Cape Town	7 286 060	12 957 497	4 777 317	25 020 875
Eden	1 105 927	2 500 068	28 805	3 634 800
Overberg	331 309	807 745	5 207	1 144 261
West Coast	6 298 587	3 294 488	2 958	9 596 033
Provincial Total per Scope	**17 025 651**	**22 420 075**	**4 815 474**	**44 261 200**

Inventory Sheet 4: Greenhouse gas emissions by sector per scope in the Western Cape

Table 45: Energy- and waste-related GHG emissions by sector per scope in the Western Cape

Western Cape province GHG emissions by Sector per scope				
Sector	**Sub-sector**	**Emissions Scope**	**Emissions (tCO_2e)**	**Total per Sector**
Stationary Units	Agriculture	Scope 2	1 344 150	1 344 150
	Commercial	Scope 1	74 134	
		Scope 2	3 773 908	3 848 042
	Industrial	Scope 1	7 107 966	
		Scope 2	8 943 551	16 051 517
	Municipal Operations	Scope 2	845 681	845 681
	Residential	Scope 1	263 228	
		Scope 2	7 106 128	7 369 355
Waste	Solid Waste	Scope 1	2 348 249	2 348 249
Mobile Units	Transport	Scope 1	7 232 074	
		Scope 2	406 657	
		Scope 3	4 815 474	12 454 205
Provincial Total GHG emissions (tCO_2e)				44 261 200

Emissions Analysis

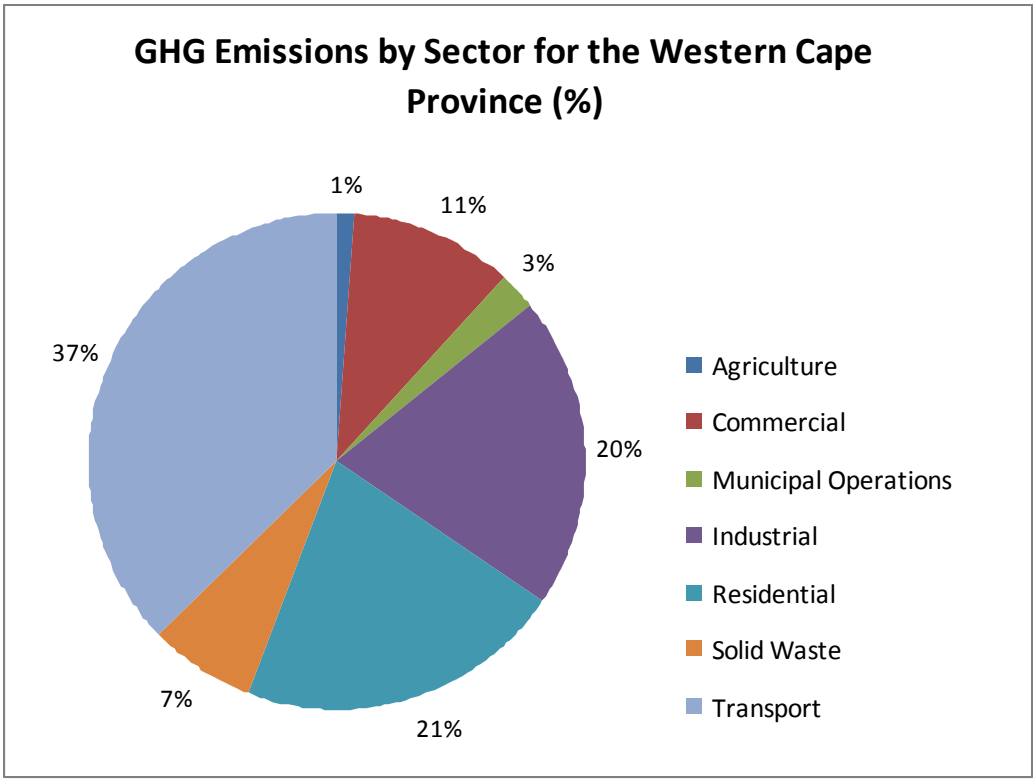


Figure 45: Energy and waste-related GHG emissions by sector in the Western Cape

Stationary Units

Municipal Operations

Solid waste management accounted for the highest amount of greenhouse gas (GHG) emissions for most local government operations (Inventory Sheet 2). When considered as a sector, solid waste management accounts for 5% of the total provincial GHG emissions. Electricity consumption by street lighting and traffic lighting, and water and wastewater treatment are the dominant sources of GHG emissions in operations that make use electricity in most municipalities. Another significant source of GHG emissions in municipalities are unaccounted for electricity uses, taken here to include transmission and distribution (T&D) losses resulting from the transmission of electricity on each municipality's electricity infrastructure. These were determined by subtracting total accounted municipal electricity sales and municipal consumption from the total electricity purchased by the municipality from the national power utility, Eskom. Ideally electricity departments of each municipality should have provided estimates of the losses based on best practice calculations which will be dependent on the distribution infrastructure.

Electricity consumption by municipal operations in the whole province accounts for about 2% of the total provincial GHG emissions. Note that this emissions figure excludes GHG emissions from solid waste management which is considered as a separate sector in the provincial inventory. Also emissions from municipal vehicle fleets were excluded in the final community (provincial) inventory so as to avoid double counting. These emissions are already accounted for in the transport sector.

Residential Sector

Emissions from this sector include all direct emissions (Scope 1) generated by the residential sector through the consumption of natural gas, paraffin and liquefied petroleum gas (LPG) and indirect emissions from electricity consumption (Scope 2). Statistics on electricity sales were obtained from individual municipalities covering areas where they are licensed to distribute. However, Eskom figures were only provided at a district level without a clear disaggregation at a municipal level. Therefore, comparison of carbon footprints at a municipal level is rendered irrelevant and only applicable at a district level. The residential sector is the third largest source of GHG emissions in the province, after the industrial and transport sectors, accounting for 17%. Electricity use (Scope 2) is the dominant source (96%) of GHG emissions within this sector as depicted in Inventory Sheet 4.

Commercial Sector

This analysis only covers emissions generated by the commercial sector through electricity, natural gas and LPG consumption within the sector. This sector accounts for 9% of the total provincial GHG emissions. Electricity accounts for 98% of GHG emissions in this sector and the rest (2%) is attributed to the consumption of both natural gas and LPG.

Industrial Sector

In the industrial sector the analysis covered direct emissions associated with stationary fuel consumption (Scope 1) and indirect emissions (Scope 2) associated with electricity consumption. Stationary fuel consumption includes consumption of fuels like coal, diesel and heavy furnace oil (HFO). Data on liquid fuel consumption is from the Southern African Petroleum Industry Association (SAPIA) and was obtained from the Department of Energy (DoE). Coal data used in this analysis only represents coal usage by big industry at a provincial level. Also diesel data was not disaggregated categorised to include the industrial sector, although past experience dictates that some diesel is consumed in industrial processes. The industrial sector accounts for the highest amount (36%) of emissions in the province. Although electricity consumption contributes 56% of emissions in this sector we see that the sector is also characterised by a high level of direct emissions 44% (Scope 1) attributed to the combustion of coal (mainly in the West Coast District), diesel and use of HFO, the former two fuels being the major contributors of emissions in this sector.

Agricultural Sector

Electricity consumption in the agricultural sub-sector in the province accounts for only 3% of the total provincial GHG emissions. The analysis therefore does not include emissions from enteric fermentation, manure management, land use and land use change and forestry (LULUCF), and soil management.

Mobile Units Sector

Transport Sector

The community transport sector includes emissions generated by both on- and off-road vehicles in the community. These emissions are based on fuel sales in each municipality as obtained from SAPIA. It should be noted that emissions from the vehicles was captured as direct (Scope 1) emissions as it was not possible to determine if some of these emissions occur outside a given municipality's geopolitical boundary. This assumes that most trips begin and end within a jurisdiction. It is known for a fact that not all fuel purchased within a municipality will be consumed within its geopolitical boundaries, e.g. trucks refuelling on their way through a municipality. However, this can be counterbalanced by the fact that some of the fuels consumed within a municipality were purchased from outside that municipality. Emissions from air and water transport systems are also reported in this analysis. These are mainly reported as indirect emissions (Scope 3) since it is difficult to obtain data separated according to whether emissions occur within a municipality, inter-city (domestic aviation) or international trips. Calculations based on fuel sales figures, fuel loaded onto airplanes, obtained from the SAPIA database.

The transport sector is the in second largest contributor of GHG emissions in the province accounting for 28%. Direct (Scope 1) emissions from the combustion of both diesel and petrol within the provincial boundaries account for 58% of total GHG emissions in this sector. The sum of trans-boundary emissions (Scope 3) attributed to air travel and marine emissions is the second largest contributor of emissions (39%) within this sector. This can be attributed to the presence of a major international airport in Cape Town and some harbours and ports spread around the province. Electricity consumption by trains accounts for 0.9% of the total provincial emissions.

Waste Sector

Solid waste

Greenhouse gas emissions associated with the management of municipal solid waste facilities (landfill sites) located within each municipality's geopolitical boundary were analysed. Municipal solid waste deposited at these landfill sites decomposes; embedded carbon is then released in the form of methane (CH_4) and carbon dioxide (CO_2). These emissions are released gradually over a number of years. Methane emissions from the landfill sites were calculated based on the total amount of municipal solid waste land-filled within individual municipalities, composition of biodegradable organic material in the waste stream. The GHG emissions were then calculated by converting the resulting methane (CH_4) into equivalent metric tonnes of CO_2 emissions using the global warming potential of methane (21) indicated above. It was difficult to determine the management processes employed at each landfill site for each municipality. It is a known that managed landfills that include site compaction and cover creates optimum conditions for anaerobic conditions for methane production to develop. In informal or poorly managed landfill sites waste degrades under more aerobic conditions generating biogenic CO_2. Different landfill management conditions have an effect on the total amount of GHG emissions generated. Importantly, many local municipalities do not have access to weighbridge facilities and, hence, the amount of waste land-filled is not recorded. This section would require further research.

Comparison of GHG emissions across district municipalities

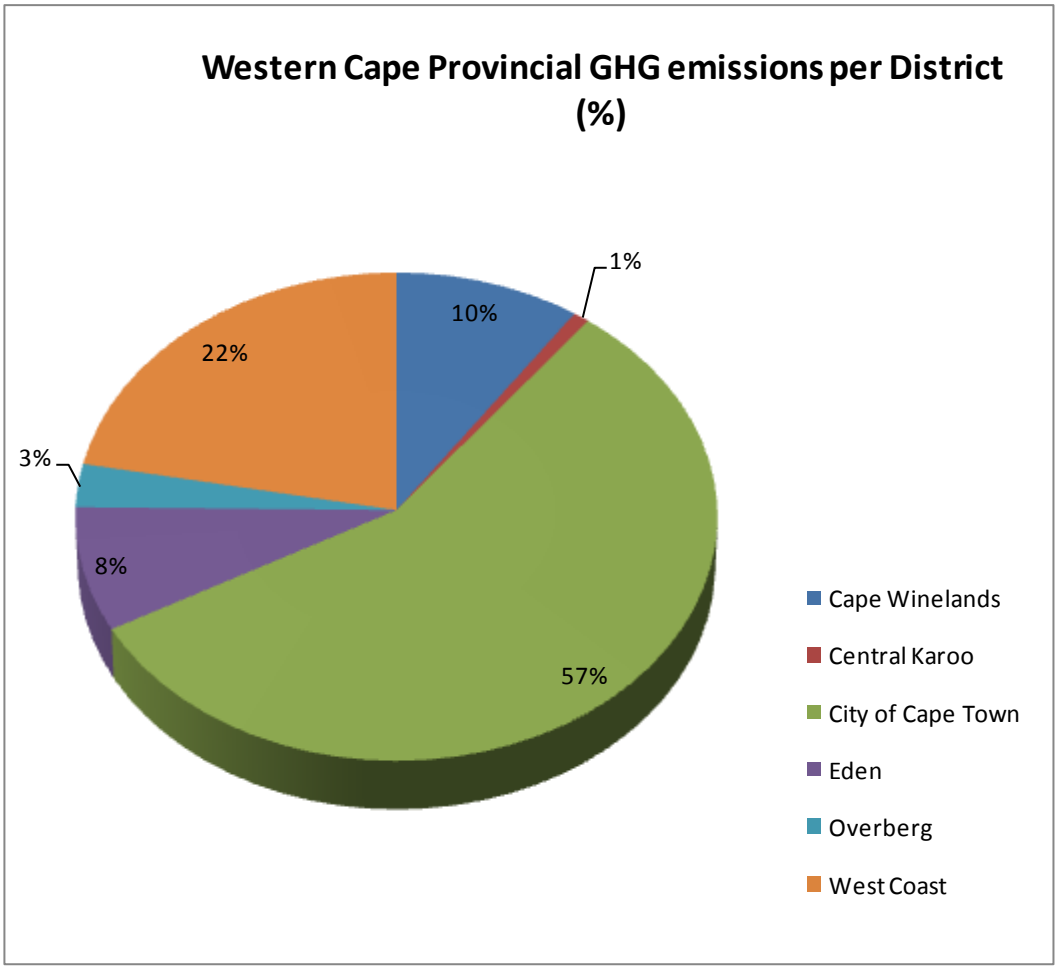


Figure 46: Comparison of energy- and waste-related GHG emissions by district in the Western Cape

In this analysis, sector and municipality emissions were amalgamated into aggregated district and province-wide emissions. The figure above provides a breakdown of GHG emissions by district municipality in the province. Cape Town metropolitan produces the largest quantities of GHG emissions accounting for 57% of the provincial total. The West Coast district municipality is the second largest contributor of emissions, contributing 22% followed by the Cape Winelands (10%). Eden is the fourth largest source of GHG emissions in the province accounting for 8%. Overberg district accounts for 3% of the Western Cape provinces GHG emissions. The Central Karoo district municipality produces the least emissions (1%) of the provinces' total emissions. This might be due to the low industrial activity taking place in this district.

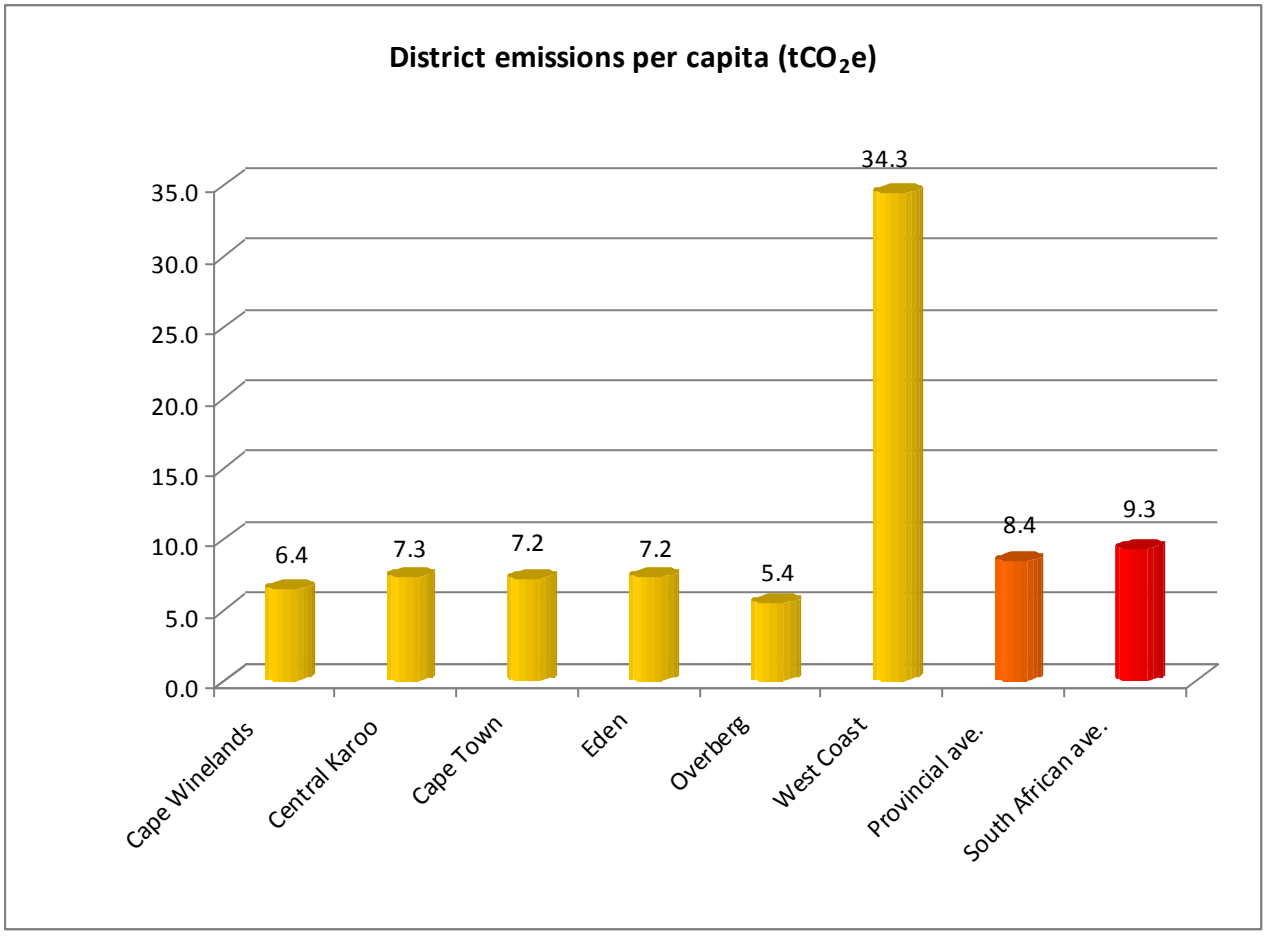


Figure 47: Per capita energy- and waste-related emissions comparison across district municipalities in the Western Cape

Applying a per capita analysis of the GHG emissions across the district municipalities in the province provides a rather different picture (see figure above). It is interesting to note that a large absolute GHG emissions figure does not translate to a high per capita emissions figure. The West Coast has the highest per capita emissions figure of 34.3 tCO_2e per person per year which is above Cape Town's figure of 7.2 tCO_2e per person per year, the latter being the largest source of absolute emissions (57%) in the province. This is as a result of the low population levels in the West Coast compared to the GHG-intensive industries in this district. The Central Karoo, which has the lowest absolute GHG emissions for a district, has a per capita figure of 7.3 tCO_2e per person per year, which is equivalent to that of the City of Cape Town. This can be attributed to the high amount of liquid fuel use by refuelling traffic that pass through the area on national highways. The per capita CO_2 emissions for most district municipalities are below the provincial average of 8.4 tCO_2e per person per year. These per capita figures are also lower than the South African national average of 9.3 tCO_2e per person per year. The national average per capita figure was calculated according to the emission figure of 461,178.5 $GgCO_2e$ reported in South Africa's Second National Communication Under the United Nations Framework Convention on Climate Change (DEA, 2011).

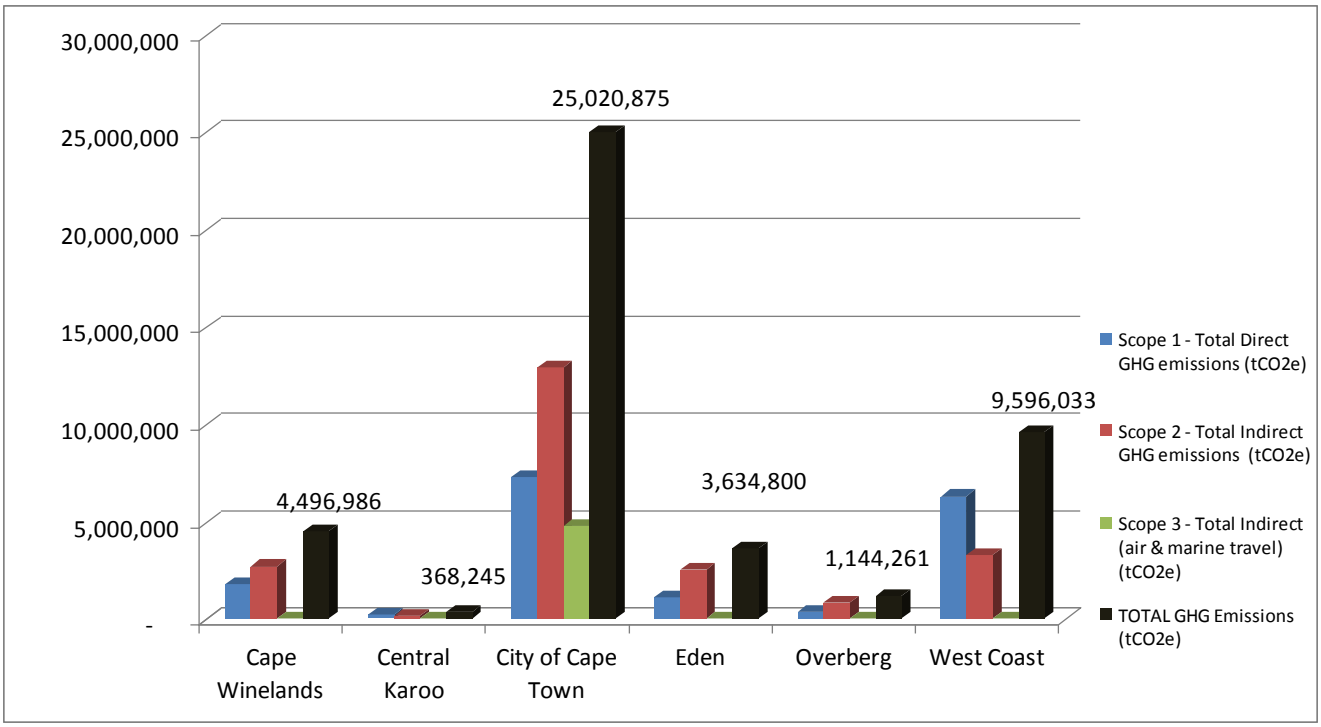


Figure 48: Energy- and waste-related GHG emissions by scope per district municipality in the Western Cape

The figure above presents GHG emissions by scope type across the different district municipalities. It can be seen that Scope 2 emissions, associated with electricity consumption, in each district municipality are the dominant source of emissions. However, the West Coast district is the exception as its Scope 1 (direct) emissions exceed indirect (Scope 2) emissions. This can be attributed to the energy intensive industries e.g. the Arcelor Mittal owned Saldanha iron & steel plant, PPC cement production and Namakwa Sands, which undertake the mining and beneficiation of heavy minerals. Most of these operations consume coal. Scope 3 (indirect) emissions associated with the aviation industry and the marine sectors are higher in the Cape Town metro than in any of the other district municipalities. This is due to the fact that this city hosts a major international airport as well as some important national harbours and ports.

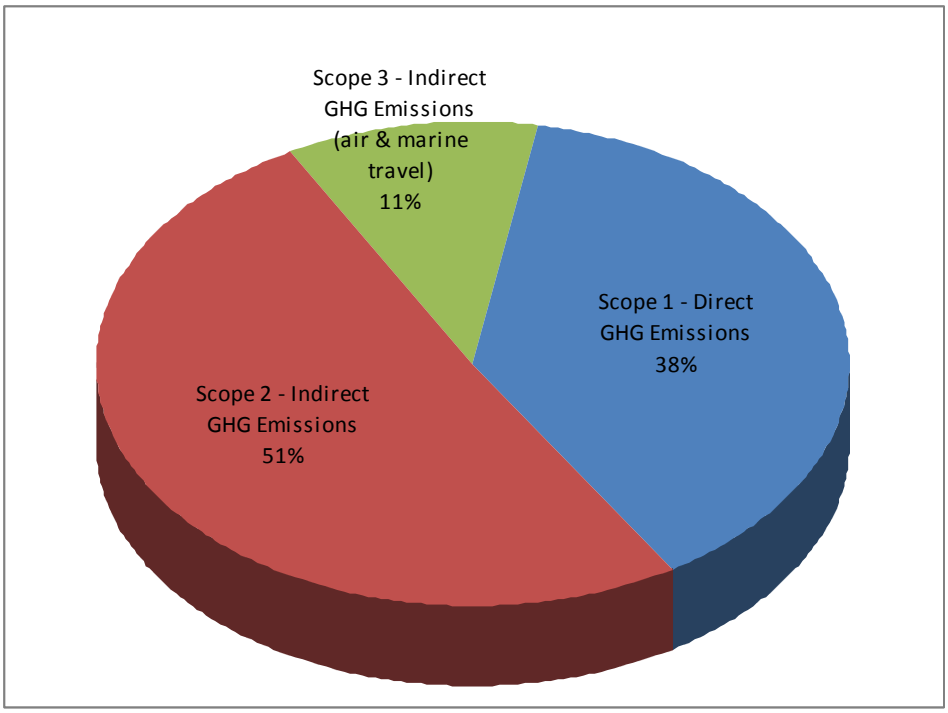


Figure 49: Energy- and waste-related GHG emissions by scope for the Western Cape (2009)

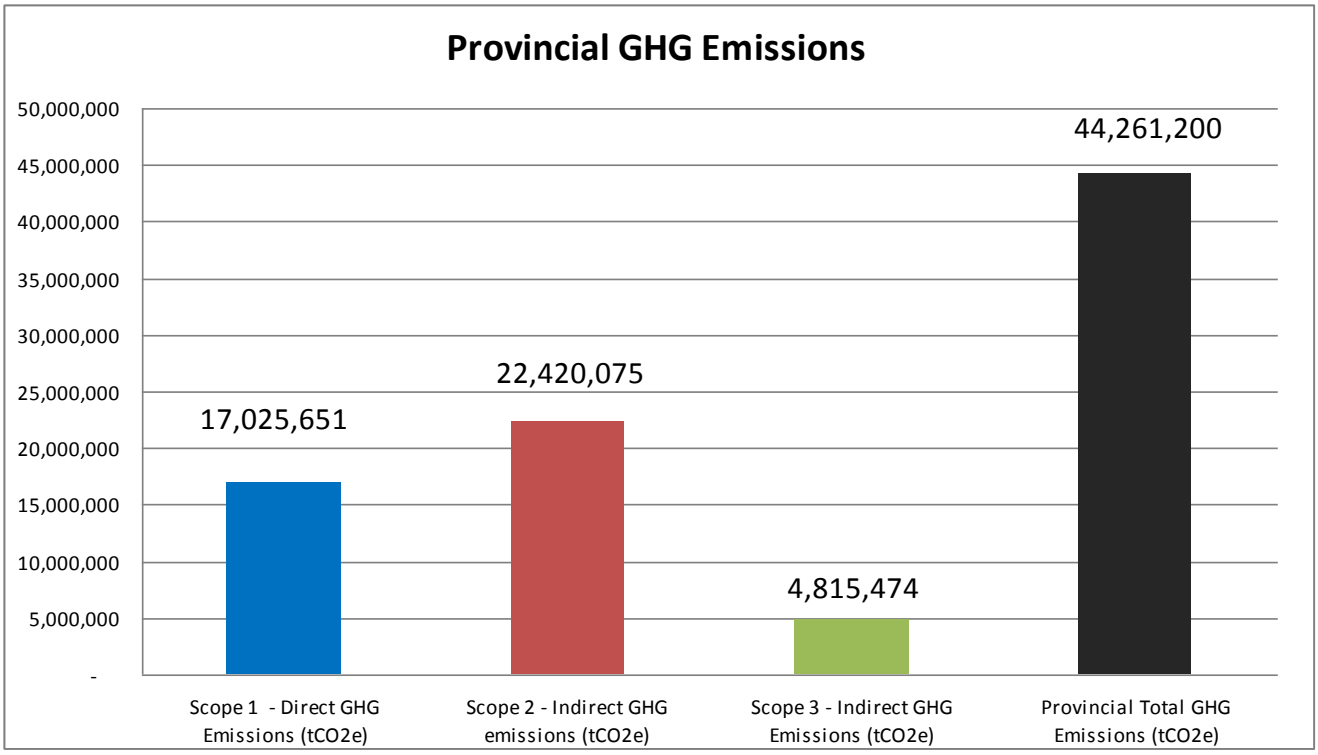


Figure 50: Western Cape summary of energy- and waste-related GHG emissions disaggregated by scope type (2009)

Conclusion

In summary, the dominant sectors in terms of emissions in the Western Cape Province are the industrial, transport and the residential sectors. These three sectors account for 81% of the province's total emissions. The dominant source of emissions in the province is attributed to the consumption of grid-supplied electricity from the national utility, Eskom. These indirect (Scope 2) emissions account for 51% of the total provincial GHG emissions. South African electricity has a large 'carbon footprint' as it based on "dirty" coal. Scope 1 emissions associated with the combustion of vehicle fuel, coal, natural gas, LPG and HFO within the provincial boundaries account for 38% of the total provincial emissions. The Western Cape's total GHG emissions are 44,261,200 tCO_2e.

APPENDICES

APPENDIX 1: WESTERN CAPE GOVERNMENT MUNICIPAL ENERGY DATA QUESTIONNAIRE 2012

The exercise of engaging municipalities in the data collection process highlighted:

- The importance of engaging high level officials initially, and getting an 'on-the-ground' data representative to hold the questionnaire response process from the municipal side;
- The importance of the initiative being government to government;
- The importance of establishing personal contact and pursuing this through the course of the data collection exercise;
- Keeping the questionnaire as short and simple as possible.

Important lessons included understanding that while Electricity departments have substantial detail on electricity distribution, it is often the Finance department that best understands the customer categories to which the electricity is distributed. A serious challenge to demand-side data collation is that municipalities all have different customer categories and these seldom consistently fall across sector lines (whether high or low income disaggregation, or commercial, industrial or residential).

The following should be kept in mind if the exercise is undertaken again:

- The question requesting the number of electrified low-income households needs to be rephrased to make it clear that this number would represent all low-income households electrified up till the specified year, instead of only low-income households electrified in the financial year of the specified year.

- Electricity by income group is useful for planning purposes, but is currently not collected by almost all municipalities. The best electricity by income use breakdown available is residential customers broken down into "indigent" and "other."

- When requesting municipalities for an estimated percentage split of electricity sales between Eskom and the municipality, it should be made clear that this is in terms of electricity kWh supply, not geographic area of supply. The need for this falls away with the levels of detailed data provided by Eskom.

- Given the extensive exploration of existing national data, some of the questions in this questionnaire may be able to fall away, making it simpler and quicker for under capacitated, busy municipalities to respond. This would require a more thorough consideration, but initial thoughts are that demographics are best collected from national data (IDPs usually obtain their information from these sources in any case); transport data is best collated nationally.

WESTERN CAPE GOVERNMENT - MUNICIPAL ENERGY DATA QUESTIONNAIRE 2012

Introduction
The data being gathered in this questionnaire will contribute to the development of a Western Cape energy consumption and GHG emissions database. It will also support energy services management and climate change response within each municipality. At the completion of the exercise each municipality will receive a local emissions and energy picture identifying key issues for their municipality.

How to fill out this questionnaire
1. We recommend that the responsibility for collating the answers to the questionnaire remains with the main contact person indicated below, but each section may be filled in by the relevant department.
2. Data should be for the **(calendar)** year 2009. If not, use the closest date and in all cases, please note the year of the information.

3. Please attach any useful data source and/or support documentation, e.g. Integrated Waste Management Plans, Integrated Development Plan, Spatial Development Frameworks etc.

Contact details of main contact person responsible for completing this questionnaire

Municipality:	
Full Name:	
Email:	
Contact Number (tel. and/or cell):	

SECTION 1: Energy Supply and Distribution

Electricity purchased from Eskom in 2009		
Total amount of electricity purchased by the municipality from Eskom (in kWh):		
Municipal electricity distribution in 2009		
Total electricity distributed by municipality (in kWh):		
Municipal electricity distribution in 2009 (by tariff)		
Tariff Type (e.g. Large Power High Voltage, Bulk, Residential)	**Sector(s) mainly served by this tariff type e.g. residential, commercial, industrial, agriculture, maritime, etc.**	**kWh sold at this tariff (2009 if possible)**
Who are your top 10 electricity users and how much electricity was sold to them in 2009? *(please list them)*		
% of electricity in municipal area distributed by the municipality (i.e. the breakdown between the Eskom supply area and the municipal supply area)	Municipal supply area (%):..... Eskom supply area (%):.....	
Electricity generation in municipality in 2009		
Are there any power generation facilities within your municipal boundaries? If so please provide detail (including fuel type, capacity, KWh/year, peaking plant, ownership)		

Electrification in 2009	
Total number of households receiving Free Basic Electricity:	
Total number of electrified low-income households:	
Electrification backlog: number of formal households still awaiting electrification	
(if not included above): Number of *informal* households still awaiting electrification:	
Is the Free Basic Alternative Energy (FBAE) policy being implemented in your municipality? If so, please provide detail.	

Coal (2009)	
Amount of coal sold in the municipality (2009) * If the data is not available, please provide contact details of any coal yards.	
Source of data:	
Number of solar water heaters installed in 2009 *(if known)*:	
Low-income housing:	
Mid- to high-income housing:	
Source of data:	

Energy Efficiency and Demand-Side Management (EEDSM) programmes i2009: Please provide details of *any* EEDSM programmes/ projects being implemented in the municipality, e.g. efficient public lighting, peak load management, behaviour change campaigns, etc.

Project	Date of inception	Savings achieved (KWh) (if any direct savings)

SECTION 2: Municipal Operations

Energy use in Municipal Operations (in 2009)		
Sector	**Unit**	**Quantity**
Buildings and Facilities	**kWh**	
Water and Wastewater Treatment Facilities	**kWh**	
Street lighting and Traffic Signals	**kWh**	
Vehicle Fleet (fuel consumption by municipality owned and operated vehicles)	**Diesel (*l*)** **Petrol (*l*)**	
Other:		

SECTION 3: Residential Sector

Electricity use in Residential Sector 2009		
Income category	**No. households**	**Electricity consumed (% or actual KWh)**

SECTION 4: Transport

Public transport services available (2009)							
Minibus taxi	Yes/No	**Car taxi**	Yes/No	**Bus**	Yes/No	**Train**	Yes/No
Note any other:							

Average cost of trip from low-income area to the town centre by:					
Minibus taxi:	R	**Bus**	R	**Train**	R

Please provide details on public, efficient and non-motorised transport initiatives in the municipality (as of 2009).

Numbers of registered vehicles in municipality in 2009:			
Private:		**Public:**	

FOR MUNICIPALITIES along NATIONAL ROADS: Please provide *any available* data on the amount of fuel (petrol/diesel) used *within* municipal boundaries as opposed to that used in long-haul trips (vehicles passing through the municipality, which only stop for fuel-ups).
Please provide notes on data and sources:

SECTION 5: Waste

Solid waste (2009)	Tonnes
Solid waste generated by the community and sent to landfill within municipal boundaries (tonnes)	
Solid waste generated by the community and sent to landfill outside municipal boundaries (tonnes)	
Solid waste from other communities and sent to landfill within municipal boundaries (tonnes)	
Biologically treated waste (composted waste) in tonnes	
Wastewater treatment and discharge (2009)	
Please provide details on how wastewater is treated within your municipal area i.e. the type of system utilised as well as volume of wastewater treated per year (in 2009)per treatment system:	

SECTION 6: Institutional Capacity

What is the current capacity to do energy and/or climate response in your municipality		
Please give an indication of the municipality's current capacity in terms of the following functions:		
Function	**Number of staff**	**Full-time / Part-time**
Electricity		
Climate change projects		
Electricity / energy savings awareness		
Health implications of fuels		
Sustainable transport		
Solar water heaters		
Addressing Energy Poverty		
Please list any relevant policies or strategies:		

SECTION 7: Socio-Economic Indicators

General Demographics	
Total population in municipal boundaries (2009):	
Population growth (2007-2010):	
Total land area of municipality (km^2):	
Number of households in municipality (2009):	
Economic activity, e.g. GGP figures (2009):	

Households by income category (2009)	
Category (e.g. low-income, mid-income, high-income, very-high income)	Number of households
Main economic activities	
Economic activity, e.g. agriculture, mining, manufacturing, tourism, etc.	% of GGP
Notes on data and data sources:	

APPENDIX 2: ESKOM SALES TO REDISTRIBUTORS VS MUNICIPAL TOTAL SALES

Eskom undertook a detailed, sector and calendar month breakdown, data analysis which they provided for use in the Provincial Energy Balance exercise. Eskom data is developed along Technical Service Areas (TSAs). The provincial analysis is done in terms of political boundaries.

The accuracy of the proportional allocations was tested by measuring Eskom sales to redistributors against municipal electricity departments' sales. Give or take, these figures should align. The table below illustrates the amount of municipal electricity sales compared with the estimated Eskom sales to the municipality according to TSA percentage allocations to municipal boundaries.

Table 46: Eskom electricity sales to redistributors vs. municipal sales

District	Eskom sales to redistributors*	Municipal sales totals**	Difference (%)
Cape Town	10 495 299 984	10 548 098 631	-0.5%
Cape Winelands	1 891 637 501	1 887 353 722	0.2%
Central Karoo	58 300 836	64 128 874	-10.0%
Eden	1 365 221 028	1 367 730 178	-0.2%
Overberg	393 081 307	394 237 045	-0.3%
West Coast	614 084 800	610 779 432	0.5%
Total	14 817 625 456	14 872 327 882	-0.4%

* Calculated according to TSA allocation methodology
** Sales according to Municipal Electricity Departments

The reason for the large discrepancy in Central Karoo is inaccurate reporting on electricity sales by municipalities. The municipal figures above were what municipalities said they bought from Eskom. The municipal questionnaire later requested information on the amount sold by tariff/sector from municipalities. There was a large discrepancy (169%) between the amount of electricity bought and the amount sold as reported by Laingsburg Municipality. A table comparing the figures given for the mount of electricity bought and the amount sold are given by district below. Negative figures indicate that municipalities "sell more than they buy" and positive figures indicate that they buy more than they sell. Any positive percentage figures in the range of 0-10% are plausible, as this is generally the amount lost through technical and non-technical losses.

Table 47: Amount of electricity bought and sold by municipalities

Metro / District	kWh (bought)	kWh (sold)	Difference
Cape Town	10 548 098 631	9 626 466 822	9%
Cape Winelands	1 887 353 722	1 737 352 188	8%
Central Karoo	64 128 874	108 761 301	-70%
Eden	1 367 730 178	1 301 416 115	5%
Overberg	394 237 045	309 914 365	21%
West Coast	610 779 432	573 800 000	6%
Total	14 872 327 882	13 657 710 791	8%

APPENDIX 3: COAL DATA METHODOLOGY FOR THE WESTERN CAPE

As coal is not regulated, obtaining this data is notoriously difficult as it relies on private companies being prepared to share their market information. The following data collection was undertaken:

- Major distributors in the province were followed up and their distribution figures and 'expert' estimates of other distribution figures were compiled.
- Data was obtained from Provincial Air Quality figures from the AEL and APPA licensing certificate data.
- The province has three large consumers: Saldanha Steel, PPC Cement and Namakwa Sands (Exarro). Coal consumption figures for Saldanha were obtained through calculations based on information on their steel production output and related energy and emissions; PPC Cement figures could not be obtained and the Provincial Air Quality figures have been used; Namakwa Sands (Exarro) provided information.
- The City of Cape Town is also a relatively large 'consumer'. Detailed coal data had been obtained for the first State of Energy report (2003) for the City and this was considered to be the most thorough study/data available.
- Figures were cross-checked to evaluate reliability. The following conclusions, or method decisions, have been made with regard to total figures and geographic and sector disaggregation:
    - the provincial Air Quality data appears to give a good approximation of provincial coal consumption (when cross-checked with the distributor information), save for the City of Cape Town, where the data needs to be clarified;
    - Cape Town State of Energy data figures were about double that of the Air quality figures and have been taken as more reliable/thorough;
    - Namakwa Sands coal is high quality anthracite (imported, largely from Thailand), however the emissions factor for local coal has been used (largely to simplify and also as the difference is slight). The figure quoted lines up closely to that allocated to 'Animal matter reduction' in the Provincial Air Quality records. For the purpose of this study this is assumed to refer to the same activity and the Air Quality figures will be used (possibly include other activities that would otherwise remain unaccounted);
    - PPC Cement: using the Air Quality records;
    - Saldanha Steel: the 2009 Sustainability Report indicates that approx 3.25 kg CO_2 of emissions resulted from each tonne of steel produced; 65% of this is attributable to coal usage (2kg). Total production in 2009 was 1.2 million tonnes of steel. Calculating the resultant emissions attributable to coal and converting this into actual tonnes of coal, provides a figure of 1,026,079 tonnes. This lines up with other Saldanha information that puts coal/coke/fluxes consumption at 1,071,000 tonnes per annum (on the ArcelorMittal web site). The West Coast Air Quality figures for 2009 have 950,000 tonnes coal allocated to Steel production. This figure lines up closely with the Provincial Air Quality data, but was some 50,000 tonnes per annum short. This study has used the larger figure.
    - Air quality has the data disaggregated on a geographic basis down to the district level and these disaggregations were used. While there may be some small amounts of consumption in other sectors, notably in the public sector (hospitals and prisons) it is also assumed, here, that coal consumption in the Western Cape Province is used within the industrial sector. This is broken down in to sub-sectors.

Table 48: Data from coal distributors

Distributor	Tonnes per month	Note
MacPahil/Coalcor	10 – 15,000	No response – many attempts; estimated distribution volumes by other distributors
Wescoal/Chandler	6 – 10,000	Failed to get a response – many attempts
Redcliff Investments	5,000	Confirmed by distributor. All to industrial production plants, notably for food and beverage production
A1 Energy Consultants	3,000	Confirmed by distributor
PGK consultants	2,000	Estimated distribution volumes by other distributors
Chargold	1,000	Estimated distribution volumes by other distributors

Table 49: Air quality data from Western Cape Government

COAL USAGE IN WC (Tons/Annum)	(AELs and APPA Certificates)						
Process	District						Total per sector (Tons/annum)
	Eden	Cape Winelands	West Coast	Overberg	COCT	Central Karoo	
Brickfields	45 000	57 882	3 240	-	40 800	96	147 018
Textile Industry	12	-	46 344	6 321	288	-	52 965
Animal Matter Reduction + fishmeal	-	-	-	-	58 908	-	58 908
Hospital Services	-	-	-	-	109 358	-	109 358
Chemicals	-	-	-	-	22 484	-	22 484
Plastics	-	-	-	-	1 440	-	1 440
Motor Industry	-	-	-	-	2 720	-	2 720
Boiler Manufacturing	-	-	-	-	22	-	22
Paper	-	-	-	-	64 076	-	64 076
Food Manufacturing	-	-	-	-	48 558	-	48 558
Laundry Services	-	-	-	-	2 880	-	2 880
Sawmill	-	-	-	-	1 920	-	1 920
Incineration	-	-	-	-	288	-	288
Packaging	-	-	-	-	5 520	-	5 520
Tannery	-	1 440	-	-		-	1 440
Cement Production	-	-	1 015 520	-	300	-	1 015 820
Lime Manufacturing	-	-	8 400	-		-	8 400
Steel Production	-	-	950 000	-	324	-	950 324
Boiler Operators not listed	23 125	96 238	582	3 168	42 160	90	165 363
Totals (tons/annum)	**68 137**	**155 560**	**2 024 086**	**9 489**	**402 045**	**186**	**2 659 503**

APPENDIX 4: INSTITUTIONAL CAPACITY IN LOCAL MUNICIPALITIES

ND = No Data

Municipality	Staff	Policy/Strategy
Breede Valley	• Electricity: 72 full-time • Electricity/energy savings awareness: 1 full-time • Solar water heaters: 1 full-time	ND
Drakenstein	• Electricity: 162 full-time; 2 part-time	• Drakenstein Municipality Green Building Manual • Vehicle fleet fuel monitoring through tracker system • Residential Load Management Project: disconnecting domestic loads for short periods to alleviate peak demand • Demand-Side Management Programme: efficient light retrofit, solar water heaters installed in new low-income housing units, geyser blankets fitted around geysers, etc
Langeberg	• Electricity: 58 full-time	ND
Stellenbosch	ND	ND
Witzenberg	• Electricity: 46 full-time • Sustainable transport: supported • Solar water heaters: INEP funding	• None
Beaufort West	• Electricity: 1 part-time • Climate change projects: 1 part-time • Electricity/energy savings awareness: 1 part-time	ND
Laingsburg	• Electricity: none (outsourced?)	ND
Prince Albert	• No information	ND
Bitou	• Electricity: 25 full-time; 3 part-time	ND
George	• Electricity: 150 full-time; 4 part-time • Electricity/energy savings awareness: 1 full-time	ND
Hessequa	• Electricity: none (outsourced?)	ND
Kannaland	ND	ND
Knysna	• Electricity: none (outsourced?) • Climate change projects, electricity/energy savings awareness, health implications of fuels, sustainable transport, solar water heaters: 3	ND
Mossel Bay	• Electricity: 72 full-time	• None
Oudtshoorn	• Electricity: 2 part-time • Climate change projects: 1 part-time • Electricity/energy savings awareness: 1 part-time • Sustainable transport: 2 full-time	ND
Cape Agulhas	• Electricity: 18 full-time • Climate change projects: 10 part-time • Electricity/energy savings awareness: 5 part-time • Health implications of fuels: 2 part-time • Sustainable transport: 8 part-time • Addressing energy poverty: 1 part-time	• Raising awareness on electricity saving programmes
Overstrand	ND	ND
Swellendam	• Electricity: 20 full-time	• None
Theewaters-kloof	• Electricity: 19 full-time	ND
Berg River	ND	ND
Cederberg	• Electricity: 12 full-time	ND
Matzikama	• Electricity: 27 full-time; 2 part-time	ND

Saldanha Bay	• Electricity: 58 full-time	• None
Swartland	• Electricity: 39 full-time	ND
Cape Town	• Electricity: 2000 full-time • Climate change projects: 4 full-time; 5 part-time • Sustainable transport: 4 full-time (including 2 interns)	• Green procurement in the City of Cape Town • Non-Motorised Transport Policy and Strategy • Cape Town Public Transport Plan • Traffic Calming Policy • Parking Policy • Densification Policy • Spatial Development Framework • Moving Mountains: Cape Town's Action Plan for Energy and Climate Change (2011) • State of Energy and Energy Futures Report (2011) • Climate Adaptation Plan of Action: Transport Sector (2011) • City of Cape Town Environmental Agenda 2009–2014 • Fleet Greening Planning Framework (2009) • State of Energy Report (2007) • Integrated Development Plan 2007–2012 • Cape Town Energy and Climate Change Strategy (2006) • Air Quality Management Plan (2006) • Integrated Transport Plan 2006–2011 • Integrated Metropolitan Environmental Policy (2003)

Further notes:

Limited information was returned on energy efficiency and renewable energy implementation and staff capacity in this area. A full capacity assessment would be required for a more representative picture.

Many municipalities do not have access to weighbridge facilities, which limits their ability to supply information on the tonnage of waste land-filled.

APPENDIX 5: REFERENCES

- ***Annual Report 2009*** by Eskom. Link: http://www.eskom.co.za/c/84/annual-report/
- ***Cape Town: State of Energy and Energy Futures Report 2011*** by Cape Town. Link: http://www.capetown.gov.za/en/EnvironmentalResourceManagement/publications/Pages/Reportsand.aspx
- ***Census 2001*** by StatsSA. Link: http://www.statssa.gov.za/timeseriesdata/main_timeseriesdata.asp
- ***City of Cape Town District Fact Sheet*** by the Western Cape Destination Marketing Investment and Trade Promotion Agency. Link: http://wesgro.co.za/publications/publications/city-of-cape-town-fact-sheet
- ***Community Survey 2007*** by StatsSA. Link: http://www.statssa.gov.za/timeseriesdata/main_timeseriesdata.asp
- ***Energy Scenarios for Cape Town - Exploring the Implications of Different Energy Futures for the City up to 2050, Aug. 2011*** by the City of Cape Town. Link: http://www.capetown.gov.za/en/EnvironmentalResourceManagement/publications/Pages/Reportsand.aspx#energyscenarios
- ***General Household Survey*** 2009 by StatsSA. Link: http://www.statssa.gov.za/timeseriesdata/main_timeseriesdata.asp
- ***Global Protocol for Community-scale Greenhouse Gas Emissions*** by ICLEI and C40 Cities Climate Leadership Group, 2012. Link: http://www.iclei.org/index.php?id=1487&tx_ttnews%5Btt_news%5D=4816&tx_ttnews%5BbackPid%5D=983&cHash=95382664f5
- ***Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories*** by the IPCC. Link: http://www.ipcc-nggip.iges.or.jp/public/gp/english/
- ***Integrated Energy Strategy for the Western Cape (draft)*** by the Department of Environmental Affairs and Development Planning (Western Cape Government), 2007. Link: http://www.westerncape.gov.za/search/index.php?q=energy+strategy
- ***Intergovernmental Panel on Climate Change***. Link: www.ipcc.ch
- ***Limited choices: An exploratory study on paraffin use in KwaZulu-Natal*** by the Human Sciences Research Council for the Paraffin Safety Association of Southern Africa.
- ***Live Vehicle Population per Registering Authority*** by eNaTiS. Link: http://www.enatis.com/newsite/index.php?option=com_content&view=category&id=71:live-vehicle-population-per-registering-authority&Itemid=19&layout=default
- ***National Energy Act***, [No. 34 of 2008], G 31638, 24 November 2008. Link: http://www.info.gov.za/
- ***Report on the Waste Characterisation Survey undertaken at selected landfill sites in the West Coast District*** by P.D. Naidoo & Associates, 2007.
- ***SAPIA liquid fuel use by municipal boundaries for the Western Cape*** by Sustainable Energy Africa, 2009. Link: http://www.cityenergy.org.za/resources/municipal-liquid-fuel-data
- ***Second National Communication under the United Nations Framework Convention on Climate Change (draft)*** by the national Department of Environmental Affairs, 2011. Link: http://www.sanbi.org/news/publication-draft-second-national-communication-snc-public-comment
- ***South Africa Energy Synopsis 2010*** by the national Department of Energy. Link: http://www.energy.gov.za/files/media/media_explained.html
- ***State of Energy in South African Cities 2006*** by Sustainable Energy Africa. Link: http://www.cityenergy.org.za/resources/energy-data
- ***State of Energy in South African Cities 2011*** by Sustainable Energy Africa. Link: http://www.cityenergy.org.za/resources/energy-data
- ***State of Energy Report for Cape Town 2003*** by the City of Cape Town. Link: http://www.capetown.gov.za/en/EnvironmentalResourceManagement/publications/Pages/Reportsand.aspx#energyscenarios
- ***State of Energy Report for the City of Cape Town 2007*** by the City of Cape Town. Link: http://www.capetown.gov.za/en/EnvironmentalResourceManagement/publications/Pages/Reportsand.aspx#energyscenarios
- ***Waste Characterisation Surveys in the Central Karoo District Municipality*** by JAYMAT Enviro Solutions cc, 2007.

- ***Western Cape Climate Change Response Strategy and Action Plan, 2008*** by the Department of Environmental Affairs and Development Planning (Western Cape Government). Link: http://www.westerncape.gov.za/eng/pubs/public_information/W/162981
- ***White Paper on Sustainable Energy for the Western Cape Province*** by the Department of Environmental Affairs and Development Planning (Western Cape Government), 2010. Link: http://www.westerncape.gov.za/eng/pubs/white_papers/2010