CITY OF CAPE TOWN | ISIXEKO SASEKAPA | STAD KAAPSTAD

THIS CITY WORKS FOR YOU

STATE OF ENERGY REPORT

City of Cape Town 2007

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Prepared for the City of Cape Town by the Palmer Development Group

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1 Introduction

The context for this report is presented in Chapter 2, which provides the policy and institutional background for the energy sector and in particular energy planning.

The primary drivers for the dynamic nature of the energy sector at present are:

- Energy security;
- Energy access, and
- Climate change.

This report is written with these drivers in mind and the analysis of the energy demand and supply data is based on the provision of an energy service that addresses these key thrusts.

The City of Cape Town (CCT) undertook its first State of Energy Report (SER) in 2003. This document follows up on and provides a review of the 2003 SER. This State of Energy Report provides an energy profile for the City of Cape Town. This is achieved by an overview of the policy context, of energy demand, and of the supply options to the metropolitan area.

Energy demand profile

Some salient points captured in this document include:

General energy demand:

- CCT contributes toward 5% of the national energy and electricity consumption.
- Relative to the national consumption pattern for the transport sector (24%), Cape Town has a significantly higher energy consumption pattern in the transportation sector (55%).
- CCT has a national emissions profile of 20Mt CO_2 p.a. giving rise to a per capita contribution of 6.4t CO_2 p.a.
- In line with the national average for energy consumption by fuel type, the CCT also displays a significant reliance on petrol and electricity, which highlights the need to diversify energy supply sources in order to ensure a sustainable economy.
- Although coal-fired electricity accounts for 28% of Cape Town's energy consumption, it results in 66% of the total carbon emissions, due to the low grade of coal used for electricity generation. By contrast petrol and diesel only make up 12% of the carbon emissions, even though these sectors account 43% of the total energy consumption within the City of Cape Town.
- In terms of local environmental air quality the CCT air quality monitoring stations recorded 162 days of poor air quality in 2003. In response to this the Air Quality Management Plan (2005) of the CCT has outlined a range of strategic actions to reduce local pollutants.

Residential energy demand:

- Residential energy consumption within the CCT (14%) is not too disparate from the national average (18%).
- In the CCT on average 50% of this consumption is for cooking, 27% for water heating and 10% for lighting. However in contrast for middle to high income users, water heating makes up 50% of the total consumption.
- In South Africa middle to high-income households meet their energy needs almost exclusively through electricity. This sector therefore holds significant potential for energy efficiency interventions. This specifically in terms of efficient appliances and technologies for lighting, water heating (solar water heaters and geyser blankets), as well as for cooking and refrigeration.
- Compared to the SER (2003) there is a noticeable decrease in the percentage of households using electricity, as opposed to other sources of energy. To a large extent this can be ascribed to the increase in the number of households, in predominantly low-income settlements, where electricity is not the primary energy source.

Industrial and commercial energy demand:

- This sector consumes 31% of the nett average energy consumption for the CCT.
- Commercial demand (8%) is mostly for lighting and air conditioning in offices, shopping malls and hotels.
- Industrial consumption (23%) is not monitored sufficiently to provide a breakdown of the sectoral consumption.
- Electricity is the primary energy source in the commercial (63%) and industrial sectors (82%).
- Energy consumption since SER (2003) shows a slight decline (2%), which could possibly be attributed to the introduction of energy efficient measures.
- Improved construction methods with the use of technologies to enhance energy efficiency in this sector will increase the CCT's international competitive advantage.

Transport energy demand:

- In the CCT, 54% of commuter travel is by private car.
- The bulk of liquid fuel usage (99%) is by private commuters (including minibus taxi's).
- A concern in this sector is that many of the transport functions are not the responsibility of the CCT. This undermines the scope for integrated strategic management, as well as the subsequent environmental impact of this sector.

Local Authority

The CCT spends in excess of R100m per annum on electricity (63%), diesel (29%) and petrol (8%) consumption. Energy efficiency interventions therefore hold significant potential for savings in this sector.

Energy supply overview

Electricity

The electricity supply to the Western Cape is currently constrained by the power transferred to this province via the Transmission Network, the limited power generated by the two Koeberg Units due to refueling, the power generated at Palmiet, as well as the power generated at various peaking power stations. It is international best practice to have reserve margins of between 15 to 30% to accommodate supply problems. The reserve capacity for the Western Cape system is just under 15%. This vulnerability in the supply system was the cause of the blackouts and load shedding that occurred during 2005 and 2006. Whether the transmission lines trip (11 November 2005), or a Koeberg unit needs to be shut down[1] the Western Cape will be affected to a greater or lesser degree.

Problems do occur in any electricity generation, transmission and distribution network. These need to be managed in such a way that the supply to the customer is as unaffected as possible. Worldwide accepted reserve margins to accommodate supply problems stand between 15-30%. This means that a 4300MW peak load system like the Western Cape's should ideally have a supply capacity of 4950MW or greater to ensure an uninterruptible supply.

Table 1-1: Current Western Cape Supply Limitations (Eskom, CCT Electricity Dept, Andrew Kenny Presentation, Mar 2006)

Transmission Lines from Eskom Network	+/- 2600MW
Koeberg Unit 1	900MW
Koeberg Unit 2	900MW
Palmiet Pumped Storage (Peak)	400MW
Steenbras Pumped Storage (Peak)	168MW
Acacia Gas Turbine	171MW
Total Generation Capacity	5139MW

This capacity shows a reserve margin of just under 15%. However, the Western Cape supply is handicapped by the size of Koeberg's reactor units. Each unit (900MW) constitutes 18% of the total generation capacity for the Western Cape. Should one of its units be shut down, the supply to the Western Cape will fall below peak demand requirements, and load shedding will most likely have to occur to avoid a system overload.

During this period, Eskom Demand Side Management (DSM) has developed an aggressive approach to mitigate the blackouts and load shedding. The mitigating actions were intended to minimise the impact on customers. However, the benefits of these mitigating actions did not totally alleviate the requirement for load shedding.
This campaign resulted in[2]:

- 5.3 million compact fluorescent lamps (CFLs) being distributed (229MW saving);
- 180 000 geyser blankets were installed (no saving figure available);
- a gas exchange programme was established which replaced 40 332 two plate stoves, 125 electrical hobs, 2 708 electrical stoves and 1 328 heaters with gas equivalents (22MW);
- an extensive electricity conservation drive involving widespread advertising of energy saving tips (estimates at 150MW saving if 20% of population respond); and
- an incentive scheme for backup diesel generators (63MW)

1 16 November 2005, 23 November 2005, 25 December 2005, 18-19 February 2006, 28 February 2006
2 Data collected from presentation by Andrew Etzinger 2007, Eskom DSM

The peak reduction achieved through this demand side management (DSM) programme for the winter of 2006 was estimated to be between 500-700MW.

Eskom has stated that the cost of building new generation capacity is about R10 million per megawatt. The equivalent DSM savings in this light over the period of crisis was around R5 billion in offset capacity. Eskom DSM plans to continue with many of these schemes in the future, as well as solar water heating subsidisation. All of these interventions are sustainably wise choices when considering the current energy picture. Despite these measures, the current situation is still vulnerable and until the peaking open cycle gas turbines are fully commissioned there is no guarantee that the energy crisis in the Western Cape is over.

Liquid fuels

There is a significant reliance on liquid fuel in our transportation (petrol, diesel, jet fuel) and low income residential (paraffin and LPG) sectors. The majority of the supply to the CCT is imported and strongly linked to fluctuations in foreign exchange rates, as well as the price of oil. Calref provides the CCT with the majority of its demand. It is unlikely that more refineries will be built in South Africa. Currently if demand exceeds the refinery's capacity, extra refined fuel needs to be imported from Bahrain or Singapore. With rapid urban growth and a resultant increase in demand, the vulnerability in the future supply of liquid fuel should therefore be a significant consideration in future growth management decisions.

2 Policy context

Presently a mismatch exists between what is being expressed by national government and the powers vested in local government to implement energy planning in a manner that allows for the optimum implementation of activities. For the purpose of this chapter, energy planning will be viewed as depicted in Figure 2-1 below. Energy planning is initiated by a set of drivers and is based on an enabling framework that comprises policy and legislation.

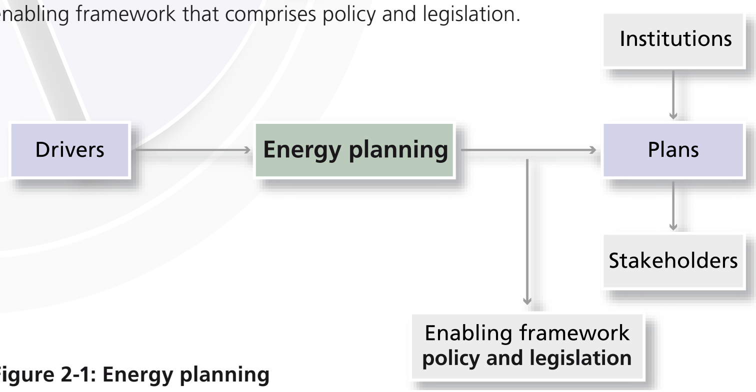


Figure 2-1: Energy planning

This chapter discusses each of the entities presented in Figure 2-1 above and provides a review of the gaps and concerns with regards to the implementation of the policies related to energy planning.

2.1 Energy planning

'Energy' per se is currently not a function dictated by Schedule 4A of the Constitution or the Municipal Structures Act (117 of 1998) with the result that to a large extent this activity is undertaken at national government level. However a number of local authorities, with Cape Town taking the lead, have responded to the issue of strategic intervention in the use of energy from a climate change mitigation perspective. This section aims to review these existing activities.

2.1.1 National

Three distinct energy planning processes operate at a national level in South Africa:

- **Integrated Energy Planning (IEP)**: driven by the Department of Minerals and Energy and covering all energy sectors. This process is intended to cover the entire energy sector and the purpose and guiding principles are contained in official policy and legislation (Energy Policy White Paper and draft Energy Bill). The purpose of the IEP process is to balance energy demand with supply resources congruent with safety, health and environment considerations. It acts as a framework within which specific energy development decisions can be made.
- **National Integrated Resource Planning (NIRP)**: carried out by the National Energy Regulator (NERSA) and related to electricity only. This NIRP is meant to act as an independent information source to stakeholders and decision-makers for ensuring security of the electricity supply. It is also aimed at assisting NERSA in its regulatory objectives.
- **Integrated Strategic Electricity Planning (ISEP)**: carried out by Eskom and relating to electricity only. Eskom's ISEP is an internal and confidential document and is not developed through a transparent process. ISEP is intended to provide strategic projections of supply-side and demand-side options to be implemented to meet long-term load forecasts. It provides the framework for Eskom to optimise investments and returns.

2.1.2 Local energy planning

2.1.2.1 Regional Electricity Distributors (REDs)[3]

The distribution of electricity in South Africa is currently receiving national attention. The electricity distribution industry is presently highly fragmented. This has resulted in inefficiencies, disparities in tariffs, unequal treatment of customers, inadequate maintenance of networks, the inability to capitalise on economies of scale and limited ability to introduce competition.

The government has called for the electricity distribution industry to be consolidated, with Eskom distribution and 187 municipal electricity utilities being amalgamated into six REDs. However, prior to this decision (taken by cabinet in October 2006), the plan was that the RED system would be metro based. To this end RED1 was formed in Cape Town in July 2005, with the mandate to be the electricity service provider for the entire jurisdictional municipal area served by the City of Cape Town and the entire jurisdictional municipal area served by Eskom.

[3] **Details taken from the report to the minerals and energy portfolio committee, Wednesday 28 February 2007**

The cabinet decision calling for the 'wall-to-wall' REDs went beyond the mandate of RED1, and the City of Cape Town requested that NERSA revoke RED1's distribution licence, and that the status quo prior to RED1 be re-established. This was granted and RED1 was closed down. The process of establishing the six 'wall-to-wall' REDs is currently being undertaken, and is being managed by EDI Holdings (Pty) Limited, a company set up by the Department of Minerals and Energy.

The process has received some resistance from municipalities, as they have argued that electricity distribution is one of their key functions in terms of the Constitution. However, the Municipal Systems Act (32 of 2000) does provide that the distribution function may be through an internal or external mechanism. Electricity is also a large source of income for municipalities, and they are not eager to lose this revenue stream.

2.1.2.2 Local energy strategies

As indicated above, municipalities play a limited but important role in the energy planning process – with their operations largely restricted to electricity distribution. Municipal level energy planning has therefore tended to focus on access to electricity and management of distribution systems. Key planning issues for the municipalities relate to maintenance and extension of distribution infrastructure and to the financing of distribution systems.

However, over the past five years a number of South African local authorities, led by the CCT, has in response to growing concern about climate change impacts and local environmental quality, started considering local energy planning more broadly than simply electricity distribution. This has led to the development of a number of local state of energy reports from some of the larger metropolitan municipalities and increasing policy interventions in the delivery of energy in a manner that is sustainable and also reduces greenhouse gas emissions.

The recent electricity and liquid fuel supply problems could result in increased relevance of municipalities in the energy planning process, specifically to ensure energy security, the provision of broader energy services, demand-side management and energy efficiency.

2.2 Key drivers in energy planning in South Africa

A number of drivers of energy planning have been formally identified in the various South African energy planning processes, specifically the IEP process of the Department of Minerals and Energy (DME). Although in large measure these can be aligned with the three broad drivers of security, access and climate change, the locally expressed drivers reflect the particularities of South Africa. Thus we see specific issues around population dynamics including impacts of HIV/AIDS on population growth, contained in the drivers identified within the draft IEP2 process which are listed below (DME, 2005)[4]:

- Security of supply
- Government policies
  - Diversification
  - Poverty alleviation
  - Job creation
  - Energy efficiency targets
  - Renewable energy targets
  - Energisation policies
- International commitments, pressure and co-operation
  - CDM, Kyoto, Carbon trading, globalisation
- Economic growth
- Availability of resources
  - Financial
  - Human
  - Capital
  - Energy reserves
- Demographics
  - Population growth
  - Urbanisation and migration
  - Health hazards (HIV, TB, etc.)
- Technological developments
  - Research and development
- Fuel prices
- Political stability

[4] Department of Minerals and Energy 2005. IEP (2) Scenarios. Downloaded from www.dme.gov.za

2.2.1 Energy security

An overview of the role of energy security in energy planning in South Africa is discussed below.

Policy on energy security

There is a stark difference between planning and regulation in the electricity sector, which is dominated by a single monopoly supplier, and the liquid fuels and gas sectors which have much more competitive and internationally open market structures. These sectors are therefore discussed separately below.

Electricity sector

Energy security is an important consideration within formal government energy policy and planning. For example, in the Renewable Energy White Paper the DME (2004) noted that 'the driving force for energy security through diversification of supply in South Africa has remained one of the White Paper on Energy Policy's key goals, since a major portion of the nation's energy expenditure is via dollar-denominated imported fuels that impose a heavy burden on the economy. Further, the South African economy, which is highly dependent on income generated from the production, processing, export and consumption of coal, is vulnerable to the possible climate change response measures implemented or to be implemented by developed countries.'

The White Paper on Energy Policy (DME, 1998) itself notes under the objective of securing supply through diversity that, 'given increased opportunities for energy trade, particularly within the Southern African region, government will pursue energy security by encouraging a diversity of both supply sources and primary energy carriers.'

Petroleum and gas sector

South Africa produced 23 571 million litres of liquid fuels product in 2005, according to the South African Petroleum Industry Association. About 36% of the demand is met by synthetic fuels (synfuels), which are produced locally, largely from coal and from natural gas. Products refined locally from imported crude oil meet the remaining 64%.

The petrol price in South Africa is linked to the price of crude oil in international markets and is quoted in US dollars (US$) per barrel. International petrol prices are essentially driven by supply and demand for product in a particular market. Crude oil prices combined with the Rand/US$ exchange rate therefore have a major impact on petrol prices. Consequently the issue of the 'oil peak' impacts South Africa directly.

The petroleum industry in SA is highly regulated in terms of market access and price. Recent regulation also contains relatively strong provision to promote the involvement of previously disadvantaged South Africans in the sector. Despite the extensive regulation of the sector there is not the same level of planning as is found in the electricity sector.

Mechanisms to address energy security

The key mechanisms in place to address security of supply have been outlined above. These include the long term IEP processes of the DME; the regulatory and planning framework of the NERSA; and the internal ISEP and corresponding Generation Plan of Eskom. Although decisions on infrastructure, new construction and urban planning at local government level would impact on future demand for energy, there is no bottom-up input into the existing planning process.

2.2.2 Energy access

An overview of the role of access to energy services and infrastructure provision in energy planning in South Africa is discussed below.

Policy on energy access

The first policy objective of the White Paper on Energy Policy (DME, 1998) was increasing access to affordable energy services. Government made it a policy priority to promote access to affordable energy services for disadvantaged households, small businesses, small farms and community services. Within the White Paper, the analysis of energy for households placed the focus on low-income and rural areas and identified the need to address problems of inadequate energy services and inconvenient and unhealthy fuels. Issues such as access to fuels and their associated appliances, fuel availability and pricing were considered. Building thermally efficient low-cost housing, presenting an opportunity to promote energy efficiency and conservation, was also considered.

The need to provide equitable access to affordable public transport was noted, and the challenges to this goal were identified. The provision of energy for smallholder agriculture, rural schools, clinics, roads, and communication infrastructure were also addressed.

Mechanisms to address energy access

A range of mechanisms to ensure access to energy have been established since 1994. Only the most significant are discussed below.

Electrification Programme

The most visible and effective outcome of the government policy on energy access was the National Electrification Programme which was implemented between 1994 and 1999. Its objective was to electrify rural and urban low-income households that were deprived of access to electricity during the apartheid period. Phase 1 of the programme aimed at electrifying an additional 2.5 million households over the three million already electrified by 1993; which would increase the national proportion of households electrified to 66% (ERC, 2004).

Integrated National Electrification Programme (INEP)

The National Electrification Programme was run by Eskom. This was converted into the Integrated National Electrification Programme and since 2002 has been run by the DME.

Electricity Basic Support Service Tariff (EBSST)

The National Electricity Basic Services Support Tariff Policy (i.e. the Free Basic Electricity Policy) was gazetted in July 2003. This policy aims to bring relief, through government intervention, to low-income households and to ensure optimum socioeconomic benefits from the INEP.

2.2.3 Climate change

'The South African government understands the urgency of action, and that the costs of doing nothing about climate change far outweigh those of taking concrete steps.'

President Mbeki, Parliament, 17 May 2007

Despite international, as well as national commitment in dealing with the causes and impacts of climate change, a lack of policy and institutional coherence is still reflected in the overview below.

Policy on climate change

Overarching climate change policy in South Africa is primarily contained within the main documents required as part of the country's obligations as signatory to the United Nations Framework Convention on Climate Change and the Kyoto Protocol.

This is the **National Climate Change Response Strategy** which was produced in 2004. The strategy was prepared by the Department of Environmental Affairs & Tourism (DEAT) with input from a wide range of stakeholders (represented mostly through the National Committee on Climate Change, the NCCC). It should be noted that all relevant national government departments were included in the processes, including the Department of Minerals and Energy.

White Paper on Energy Policy (1998)

The White paper contains the following broad statement related to reduction of emissions harmful to the environment:

Section 3.2.2.4: 'Government will work towards the establishment and acceptance of broad national targets for the reduction of energy-related emissions that are harmful to the environment and to human health. Government will ensure a balance between exploiting fossil fuels and maintenance of acceptable environmental requirements'.

Climate change and energy planning

The IEP(1) produced by DME in 2003 contained a consideration of the CO_2 emissions of each of the four scenarios considered in the plan (three scenarios and baseline). In all three scenarios a reduction in CO_2 emissions is predicted although this reduction takes place more significantly in one of the scenarios based on the reduced use of coal (for both power generation and as an end use fuel).

The IEP(2) process contains a specific scenario driven by low carbon emissions. However, interviews with key informants suggest that the IEP process is not yet significantly influenced by climate change concerns.

Climate Change Research & Development Strategy for South Africa

A recent document of importance with regard to climate change and research is the Climate Change Research and Development Strategy. The Department of Environmental Affairs & Tourism and the Department of Science and Technology have been collaborating on the identification of a Climate Change Research & Development Strategy for South Africa. Key government departments and parastatals involved in the preparation and subsequent implementation of such a strategy include:

Government departments	Parastatal institutions
Department of Environmental Affairs & Tourism Department of Science and Technology Department of Minerals and Energy Department of Water Affairs & Forestry Provincial Government Departments	National Research Foundation Council for Scientific and Industrial Research (CSIR) Agricultural Research Council Water Research Commission Medical Research Council South African National Biodiversity Institute Mintek South African Energy Research Institute/ Energy Development Corporation South African Weather Bureau South African Environmental Observation Network

Mechanisms to address climate change

There are no specific mechanisms for integrating climate change into national energy planning aside from the stakeholder planning processes. The DEAT has recently launched a 'Long Term Mitigation Scenario' process. This process will look at mitigation options in the South African economy and will inform energy planning by researching and modelling mitigation options including macro-economic studies.

In this regard, once more, little cognisance has been given to the potential of local strategies for reducing future demand, promoting energy efficiency and the provision of alternate energy services, in supporting long-term mitigation of South Africa's greenhouse gas emissions and the provision of energy services in a manner that is sustainable.

2.3 Enabling framework for energy planning

The enabling framework for energy planning in South Africa is provided by legislation, policy instruments and strategies that are presented below.

2.3.1 Legislation

In summary, the following pieces of legislation have shaped the structure and function of the energy sector in South Africa (ERC 2004). It is notable that much of it relates to electricity, particularly the early legislation.

Petroleum Products Act (20 of 1977)

Relates to the saving of petroleum products and an economy in the cost of their distribution.

Eskom Act (40 of 1987)

Defines the responsibilities of Eskom.

Electricity Act (41 of 1987)

Defines the structure, functions and responsibilities of the Electricity Control Board, and assigns the sole right of electricity supply within municipal boundaries to local government authorities.

Electricity Amendment Act (58 of 1989)

Amends the Electricity Act, 1987 to provide for a levy on electricity; ensuring that a license shall not be required for the generation of electricity; and to provide for the transfer of servitudes on the transfer of undertakings; and other incidental matters.

Nuclear Energy Act (3 of 1993)

To bring all nuclear activities funded by the state under the control of the atomic energy, with specified exceptions.

Electricity Amendment Act (46 of 1994)

Amending the Electricity Act, 1987 by providing for the continued existence of the Electricity Control Board as the National Electricity Regulator (NER), and applying certain provisions of the Act to other institutions and bodies.

Electricity Amendment Act (60 of 1995)

The Electricity Act (41 of 1987) was further amended to establish the National Energy Regulator as a juristic body; to make provision for the appointment, conditions of employment and functions of the chief executive officer and employees; and for the funding and accountability of the NER.

The National Nuclear Regulator Act (47 of 1999)

The Act amended the governance of nuclear energy.

RECENT REGULATORY REFORMS

The Gas Act (48 of 2001)

Made for the orderly development of the piped gas industry and established a National Gas Regulator.

The Eskom Conversion Act (13 of 2001)

The Act changed Eskom into a public company.

The Mineral and Petroleum Resources Development Act (28 of 2002)
Makes provision for equitable access to and sustainable development of the nation's mineral and petroleum resources.

The Gas Regulator Levies Act (75 of 2002)

The Act provided for the imposition of levies by the National Gas Regulator.

The Petroleum Pipelines Act (60 of 2003)

The Bill seeks the establishment of a national regulatory framework for petroleum pipelines, and provides for the licensing of persons involved in the manufacturing or sale of petroleum products.

The National Energy Regulator Act (40 of 2004)

Established the National Energy Regulator of South Africa (NERSA), with the mandate to undertake the functions of the Gas Regulator as set out in the Gas Act (48 of 2001), the Petroleum Pipelines Regulatory Authority as set out in the Petroleum Pipelines Act (60 of 2003) and the National Electricity Regulator as set out in the Electricity Act) (41 of 1987) as amended.
It replaced the National Electricity Regulator in this latter function.

Electricity Regulation Act (4 of 2006)

Established a national regulatory framework for the electricity supply industry and makes the National Energy Regulator the custodian and enforcer of the national electricity regulatory framework. It also provides for licences and registration as the manner in which generation, transmission, distribution, trading and the import and export of electricity are regulated.

2.3.2 Policy

Most of the existing recent policy for the energy sector is contained within two White Papers:
- White Paper on Energy Policy of Republic of South Africa December 1998
- White Paper on Renewable Energy 2003

White Paper on Energy Policy of Republic of South Africa December 1998

An initial white paper on energy policy was produced in 1986. This was superseded in 1998 by the most recent 'White Paper on Energy Policy'. The development of this White Paper was triggered by the change of government in 1994, the need to make energy policy more transparent and the various changes in the sector which had been brought into being via the democratisation of South African Society.

White Paper on Renewable Energy 2003

This Paper built on sections in the White Paper on Energy Policy on the subject of renewable energy and sets out government's vision, policy principles, strategic goals and objectives for promoting and implementing renewable energy.

The White Paper on Renewable Energy does not specifically mention Integrated Energy Planning, but it does provide policy on issues of energy security. It re-emphasises that a key goal for South Africa remains **'energy security through diversification of supply'** (as stated in the White Paper on Energy Policy). It then states that renewable energy is a mechanism for achieving this and states a desire to establish a renewable energy industry in South Africa 'producing modern energy carriers that will offer in future years a sustainable, fully non-subsidised alternative to fossil fuels'. A medium-term (10 year) target is then set of:
10 000 GWh (0.8 Mtoe) renewable energy contribution to final energy consumption by 2013, to be produced mainly from biomass, wind, solar and small-scale hydro. The renewable energy is to be utilised for power generation and non-electric technologies such as solar water heating and bio-fuels. This is approximately 4% (1667 MW) of the projected electricity demand for 2013 (41539 MW).

However, in spite of the clear and promising purpose statement, the draft document provides little specific direction on promoting different renewables sources, and as it stands may be of limited help in moving to a more sustainable mix.
In particular, two economically and environmentally sound options – solar water heating and passive solar building design – are

not adequately stressed given their proven track record, financial feasibility and potential impact. The next version of the policy document is expected soon, and will hopefully provide clearer guidance of how the very sound 'purpose statement' is to be translated into reality.

2.3.3 Strategies

Energy Efficiency Strategy South Africa 2005

The vision of the strategy is to contribute towards affordable energy for all, and to minimise the negative effects of energy usage upon human health and the environment. This will be achieved by encouraging sustainable energy development and energy use through efficient practices.

Draft Biofuels Industry Strategy 2006

This document presents the proposed South African Biofuels Industry Draft Strategy and further outlines the government support and approach to addressing policy, regulations and incentives for Biofuels.

Integrated National Electrification Programme (INEP)

The government's intention is to achieve universal household access to basic electricity and the INEP remains one of the primary means for achieving this.

Free Basic Electricity Policy

The National Electricity Basic Services Support Tariff Policy (i.e. the Free Basic Electricity Policy) was gazetted in July 2003. This policy aims to bring relief, through government intervention, to low-income households and to ensure optimum socioeconomic benefits from the INEP.

Integrated Household Clean Energy Strategy

The DME has developed an Integrated Household Clean Energy Strategy (2003), which incorporates, amongst others, measures such as the low-smoke generating top-down ignition of coal fires, the manufacture and distribution of low-smoke fuels and housing insulation and design, as well as also in the longer term measures such as cleaner fuels (liquids and gases) and stoves. The strategy is seen as providing cleaner household fuels in the transition period during which many households are using coal in preference to other fuels or because they do not yet have access to electricity.

2.3.4 Key institutions in energy planning

Table 2-1 provides a brief description of each institution and its role in the energy planning process. It should be noted that there are a range of other institutions in the energy planning process and the table is not comprehensive.

Table 2-1: Key Institutions in energy planning

Name	Description and broad function
Government departments, institutions and structures	
National Department of Minerals and Energy: Directorate: Energy Planning & Development	National government department with mandate to provide services for effectual transformation and governance of minerals and energy industries for economic growth and development. DME has a directorate dedicated to energy planning. Its objectives are to: • Actively contribute to sustainable development through energy interventions; • Redress past imbalances and bridge the gap between the first and second economies; • Implement energy economic policies and legislation; and • Provide Operational Energy Information and Petroleum Licensing Systems.
National Department of Public Enterprises (DPE)	The DPE is the formal 100% shareholder of Eskom. In this regard it is also the conduit of state finance to Eskom and is in a position to influence capital investment decisions of the utility.
National Energy Regulator of South Africa (NERSA)	The National Energy Regulator (NERSA) is the regulatory authority established in terms of the National Energy Regulator Act (40 of 2004) with the mandate to undertake the functions of the Gas Regulator as set out in the Gas Act (48 of 2001), the Petroleum Pipelines Regulatory Authority as set out in the Petroleum Pipelines Act (60 of 2003) and the National Electricity Regulator as set out in the Electricity Act (41 of 1987) as amended.
Central Energy Fund (CEF)	CEF is a private company but is governed by the CEF Act. Its purpose is to finance and promote the acquisition of coal, the exploitation of coal deposits, the manufacture of liquid fuel, oil and other products from coal, the marketing of these products and any matter connected with their acquisition, exploitation, manufacture and marketing. CEF is also mandated to address the acquisition, generation, manufacture, marketing or distribution of any other forms of energy and research connected therewith. The CEF group of companies focuses on gas and oil exploration, oil trading, petroleum products, promoting offshore and onshore exploration, tank terminal management, pollution prevention and control, gas infrastructure development, renewable energy and low-smoke fuels. It consists of eight operating subsidiaries, each performing quite distinct functions, which are listed below: • PetroSA • iGas • Petroleum Agency SA • Oil Pollution Control SA (OPCSA) • South African National Energy Research Institute (SANERI) • The National Energy Efficiency Agency (NEEA) • The Strategic Fuel Fund Association (SFF) • Energy Development Corporation (focusing specifically on renewable energy resources).
SALGA (SA Local Government Association)	Municipalities in South Africa are Constitutionally mandated to provide electricity services and are thus key players in the electricity distribution industry. Municipalities are also important role-players in determining other energy use patterns, especially in the housing and transport sectors. SALGA represents municipalities in South Africa and has a strong engagement with national government on issues affecting the electricity supply industry.
Energy Producers	
Eskom	Eskom Holdings Limited is a public company created by the Eskom Conversion Act (13 of 2001). Eskom generates, transmits and distributes electricity. It generates 95% of electricity used in South Africa. Eskom bears direct responsibility for its own investment plans in generation, transmission and distribution under the regulatory oversight of NERSA.

2.4 Key stakeholders in energy planning

The stakeholders in energy planning (Table 2-2) are distinguished from the key energy planning institutions by their relative roles in the energy planning process – with the stakeholders having a less direct role in energy planning than the key institutions. There is a degree of judgement in this distinction, as some stakeholders could at times be classified as key institutions. This is particularly so in the liquid fuels sector where there are less formal national planning processes. Nevertheless, the distinction made should be generally valid. Similarly, the list is not comprehensive and a judgment has been made as to the most important actors.

Table 2-2: Key stakeholders in energy planning

Name	Description and broad function
Government departments, institutions and structures	
National Department of Science & Technology (DST)	The mandate of this department is to develop science and technology in South Africa. It does this primarily through its National System of Innovation for communities, researchers, industry and government. The DST is responsible for R&D strategy, including climate change related R&D and other areas relevant to energy planning.
National Department of Environmental Affairs & Tourism (DEAT)	DEAT's mandate covers both environment and tourism. Regarding the environment, its mandate is to ensure the protection and improvement of the quality and safety of the environment and to promote sustainable development and the conservation of natural resources. South Africa's input to the Kyoto Protocol and United Nations Framework Convention on Climate Change (UNFCCC) is supported and administered through the Chief Directorate Air Quality within DEAT.
NCCC National Committee for Climate Change	This committee is made up of a wide range of stakeholders and advises DEAT on national climate change policy and assists DEAT in its role with regards to UNFCCC and the Kyoto Protocol.
Energy producers	
PetroSA (Petroleum Oil & Gas Corporation of SA)	Established in June 2000 (merging Soekor and Mossgas). Its goal is to be the leading integrated provider of oil, gas and petrochemicals competitively in South Africa (falls under CEF).
Academic and research institutions	
Energy Research Centre (ERC)	Multi-disciplinary energy research centre. Part of the University of Cape Town. The ERC has been very influential in its role in providing technical energy modelling and planning support to the DME, ESKOM and NERSA in the various energy planning processes.
South African National Energy Research Institute (SANERI)	SANERI is a subsidiary of the CEF and is responsible for facilitating skills development and undertaking research and technology development which will ensure the full utilisation and optimisation of South Africa's energy resources. The research institute is newly established and is based at the CEF's head offices.
Council for Scientific and Industrial Research (CSIR)	The CSIR was established by an Act of Parliament in 1945 and is one of the leading scientific and technology research, development and implementation organisations in Africa . It is situated in Pretoria and represented in each of the nine provinces of South Africa. The CSIR undertakes and applies directed research and innovation in science and technology to improve the quality of life of the country's people.
Industry associations	
Energy Intensive Users Group (EIUG)	Established to promote the interests of large energy users to ensure that low cost, good quality and reliable energy is available to industry in South Africa. The EIUG represents energy users who in combination use about 60% of the country's electricity.
South African Petroleum Industries Association (SAPIA)	SAPIA was established in 1994 to represent the common interests of the petroleum refining and marketing industry in South Africa and to promote an understanding of the industry's contribution to economic and social progress.
Chamber of Mines	The Chamber of Mines of South Africa is a prominent industry employers' organisation which exists to serve its members and promote their interests in the South African mining industry. Its primary role is to provide strategic support and advisory input to its members. It facilitates interaction amongst mine employers to examine policy issues and other matters of mutual concern to define desirable industry-level stances.
Other	
South African National Energy Association (SANEA)	SANEA represents a hub for the exchange of energy related information between South Africans and between South Africa and players internationally, via the World Energy Council networks. In so doing, SANEA stimulates original thought and catalyses transformation of the energy sector. Its purpose is to promote the sustainable supply and use of energy.
Sustainable Energy and Climate Change Project (SECCP)	The objective of the Sustainable Energy and Climate Change Project (SECCP) is the promotion of policies and measures for sustainable energy and climate change response in South African development and energy planning.

2.5 Local government in relation to energy planning

2.5.1 Regional Electricity Distributors (REDs)[5]

The distribution of electricity in South Africa is currently receiving national attention. The electricity distribution industry is presently highly fragmented. This has resulted in inefficiencies, disparities in tariffs, unequal treatment of customers, inadequate maintenance of networks, the inability to capitalise on economies of scale and limited ability to introduce competition.

The government has called for the electricity distribution industry to be consolidated, with Eskom distribution and 187 municipal electricity utilities being amalgamated into six REDs. However, prior to this decision (taken by cabinet in October 2006), the plan was that the RED system would be metro based. To this end RED1 was formed in Cape Town in July 2005, with the mandate to be the electricity service provider for the entire jurisdictional municipal area served by the City of Cape Town and the entire jurisdictional municipal area served by Eskom.

The cabinet decision calling for the 'wall-to-wall' REDs went beyond the mandate of RED1, and the City of Cape Town requested that NERSA revoke RED1's distribution licence, and that the status quo prior to RED1 be re-established. This was granted and RED1 was closed down. The process of establishing the six 'wall-to-wall' REDs is currently being undertaken, and is being managed by EDI Holdings (Pty) Limited, a company set up by the Department of Minerals and Energy.

The process has received some resistance from municipalities, as they have argued that electricity distribution is one of their key functions in terms of the Constitution. However, the Municipal Systems Act (32 of 2000) does provide that the distribution function may be through an internal or external mechanism. Electricity is also a large source of income for municipalities, and they are not eager to lose this revenue stream.

2.5.2 Local energy strategies

The City of Cape Town has been driven by international best practise to pursue a reduction in the future demand for energy, the investigation of alternate sources of energy, along with the promotion of efficiency in the use of energy. This action has, however, been driven from an environmental perspective (climate change) and would require stronger coherence and integration with urban planning, electricity supply and demand management, as well as other line function drivers of energy consumption.

The City has a range of policies and strategies that it has implemented in its drive to face the challenges of reducing the 'carbon footprint' of the metropole. These include:

- **Integrated Metropolitan Environmental Policy for the CCT (IMEP):** The IMEP has identified 15 sectoral approaches (environmental themes) that need to be addressed by the City of Cape Town.
- **The State of Energy Report (2003):** This document provides a picture of the energy situation in 2003 and highlights challenges that are being faced by the sector.
- **City of Cape Town's Energy and Climate Change Strategy (2006):** In line with the strategic imperative of the City's IMEP, this document, with the State of Energy Report as its informant, aims to set sustainable goals on the supply side and per sector on the demand side, and provides long and short term measures in order to achieve these goals.
- **Air Quality Management Plan (2006):** In line with the strategic imperative of the City's IMEP, this document aims to ensure that clean air is achieved and maintained in the City of Cape Town over the next 10-20 years.
- **Integrated Transport Plan for the CCT (ITP) (2006):** In line with the requirements of the Integrated Development Plan (IDP) the City has developed an integrated transport plan and it aims to provide transport in a manner that is sustainable to both the commuters and the environment in an attempt to decrease the impact that the transport sector has on the energy consumption and air pollution profiles within the City.

As is the cross-cutting nature of energy issues, specifically as it relates to urban management, the implementation of these strategies are proving to be complex and difficult, due in part to the cross-cutting nature of implementation and that this is a totally new area of engagement for the City. Currently aspects of the activities mentioned above are dealt with by a range of portfolio committees and line function departments, with no coherence or co-ordination of strategic efforts.

2.5.3 Constitutional and municipal legislative support

The current interpretation of the mandate of local government in energy planning and implementation is still limited to legislation which predates our Constitution, which provides a broad scope to local government to prioritie the promotion and implementation of renewable energy and energy efficiency measures.

[5] **Details taken from the report to the minerals and energy portfolio committee, Wednesday 28 February 2007**

This is indicated below:

Constitution:

Section 152 Objects of local government

(1) (b) to ensure the provision of services to communities in a sustainable manner

(c) to promote social and economic development

(d) to promote a safe and healthy environment

Section 153 Developmental duties of municipalities

A municipality must –

(1) (a) structure and manage its administration and budgeting and planning processes to give priority to the basic needs of the community and to promote the social and economic development of the community

Section 156

(1) Powers and functions of municipalities refers to Schedule 4 Part B and Schedule 5 Part B which refer to functional areas of concurrent competence which are local government matters. Many of these are related to energy and climate change issues, such as:

Schedule 4 Part B

Air pollution
Building regulations
Electricity and gas reticulation
Local tourism
Municipal planning
Municipal public transport
Water and sanitation systems, etc.

Schedule 5 Part B

Refuse removal, refuse dumps and solid waste disposal
Street lighting
Traffic and parking, etc.

Sections 24 and 26 are referred to in the Municipal Systems Act:

Section 24: Everyone has the right -

(a) to an environment that is not harmful to their health or well being and

(b) to have the environment protected, for the benefit of present and future generations through reasonable legislative and other measures that:

(i) prevent pollution and ecological degradation, and

(iii) secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development.

Section 26 (1) everyone has the right to have access to adequate housing…

Municipal Systems Act

Chapter 5 Integrated Development Planning

Part 1 Municipal planning to be developmentally oriented

Section 23 (1) A municipality must undertake developmentally oriented planning so as to ensure that it –

(a) strives to achieve the objects of local govt set out in section 152 (as above) of the Constitution

(b) gives effect to the developmental duties as required by section 153 (as above) of the Constitution

(c) together with other organs of state contribute to the progressive realisation of the fundamental rights contained in sections 24…26… (see above) of the Constitution.

2.6 Gaps and concerns with regard to the implementation of energy planning policies

A key issue with regard to the various energy planning processes outlined above that has emerged is the **absence of integration and coherence in national energy planning**. Linked to this is the failure of the current planning system to clearly and effectively allocate responsibility for planning and investment decisions in the energy sector and to provide for oversight over the implementation of that responsibility that has been allocated.

The current NIRP approach fails to take sufficient account of local authorities, who are retailers to around half of the electricity customer load in South Africa. In a recent review of the local government 'Integrated Development Plans' (IDPs) (the primary planning tool for local government in South Africa), very few medium or small-size municipalities had included energy or climate change issues within these important documents. The primary reason is that **energy is not seen as a local competency** even though it impacts on a range of local functions. Local government is in a position to impact urban growth management and its relation to future energy demand.

With regards to the support of **independent power producers** and the ability to sell electricity into the grid, no clear position is available yet, leaving the local municipalities with the option of purchasing electricity only from ESKOM.

All indications are that the role of local government in energy planning should be reviewed, specifically in areas such as the provision of broader energy services, demand-side management and energy efficiency.

However, there remains a lack of support and suitable tools from a national level to allow local government to implement energy efficiency and also to provide equitable and affordable energy choices as a response to energy poverty.

3 Methodology

The baseline is the 2003 State of Energy Report. This current review is based as much as possible on existing data. This resulted in two problems:

- Reliability of the information; and
- Accuracy of the information

Gigajoule (GJ) conversion factors are taken from the Energy Information Administration, USA 2001 and emission coefficients used are based an a study conducted by the Palmer Development Group, providing figures based on local coal quality.

Data was sourced from the CCT and Eskom. In many instances the availability of data from Eskom was a problem as they do have the data but access was not allowed. The CCT data set was not very extensive and secondary sources had to be used. Data collected from research done by the Energy Research Institute, as well as Sustainable Energy Africa, was used extensively to cross-check questionable data. This report has furthermore been complemented by the Integrated Energy Baseline Summary undertaken as part of the Integrated Resources Management for Urban Development Program funded by the UNDP.

Above-mentioned sources were supplemented with interviews with various officials within the CCT and other role-players in the CCT Energy sector to obtain reliable and accurate information. The primary areas where data was lacking were:

- All the informal settlements; and
- The transport sector.

Existing data sets were extrapolated and expanded where the information was appropriate.

In general an accurate account of energy usage within the CCT is required and it is expected that the SAP system currently being implemented within the CCT will provide this. In terms of transport sector data, the establishment of a transport authority might remedy this as transport is a function that spans local, provincial and national government.

The emissions profiles for the various sectors and fuel sources was calculated by relating the fuel source back to the volume of CO_2 produced from burning South African coal by considering the calorific value of the particular fuel source and using emission factors for South African coal.

4 Energy demand overview

This chapter presents an overview of the energy demand within the CCT. It provides a comparison of the energy consumption within the CCT with that of the Western Cape and the rest of South Africa and the other metros. The emissions associated with the provision of energy services are presented and finally the factors that impact demand are discussed.

4.1 Energy consumption

Energy consumption within the CCT, with a population of approximately 3.2 million, is 5% of the total energy consumption of South Africa (See Table 4-1). After Ekurhuleni, which has a population of approximately 2.8 million, it is the second highest consumer of energy amongst the metros. The Gross Geographic Product (GGP) of the CCT is the second highest of all the metros, after the City of Johannesburg, and accounts for 11.1% of the national GGP. The electricity consumption within the CCT is 5.2% of the national electricity consumption, very close to its energy consumption figure, indicating a close link between energy and electricity consumption with the CCT.

Table 4-1: Population, energy consumption, Gross Geographic Product (GGP) and electricity consumption for South Africa, Western Cape and the metros (State of Energy in South African Cities, 2006; Draft Western Cape Integrated Energy Strategy, 2007)

	Population		Energy consumption		GGP			Electricity consumption	
	People (million)	% SA	GJ (million)	% SA	2004 ZAR (million)	% SA	Per capita	KWh (million)	% SA
South Africa	46.6		2 718		1 297 399		27 849	226 734	
Western Cape	4.7	10.0	250	9.2	190 977	14.7	40 633	224 78	10.9
City of Cape Town	3.2	6.6	136	5.0	143 996	11.1	46 913	11 874	5.2
City of Johannesburg	3.6	7.7	131	4.8	207 121	15.9	57 765	12 471	5.5
City of Tshwane	1.7	3.6	92	3.4	106 845	8.2	63 643	7 934	3.5
Ekurhurleni	2.7	5.9	167	6.2	91 866	7.1	33 270	12 740	5.6
eThekwini	3.3	7.0	127	4.7	118 262	9.1	36 170	10 675	4.7
Nelson Mandela	1.0	2.2	30	1.1	34 522	2.7	34 049	3 068	1.4
Metro Total	15.4	33	684	25.2	702 612	54.2	45 688	58 763	25.9

4.1.1 Energy consumption per sector

Sectoral energy consumption provides a picture of which economic sectors are the predominant energy consumers within the City, this will be affected by development costs related to energy supply and energy use. The following figures provide a comparison of the sectoral energy consumption of South Africa as a whole with that of the Western Cape and the CCT. What is very apparent is the huge proportion of energy consumed by the transport sector in the CCT (55%) relative to the national energy consumption by the transport sector (24%). The residential energy consumption within the CCT is 14% and is not too disparate from the national residential consumption which is 18%. Energy consumption by industry in the CCT is 23%, much lower than the national (40%) or provincial (46%) energy consumption, which is a result of the absence of heavy industry within the CCT. The CCT sectoral energy consumption patterns will be discussed in more detail in subsequent chapters.

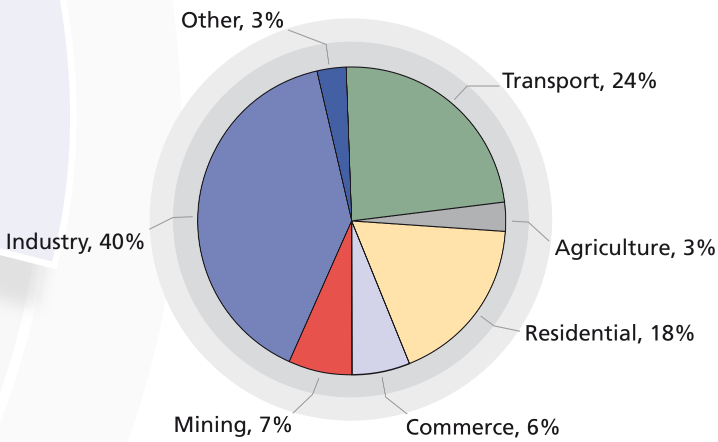


Figure 4-1: South African energy use by sector (State of Energy in South Africa, 2006)

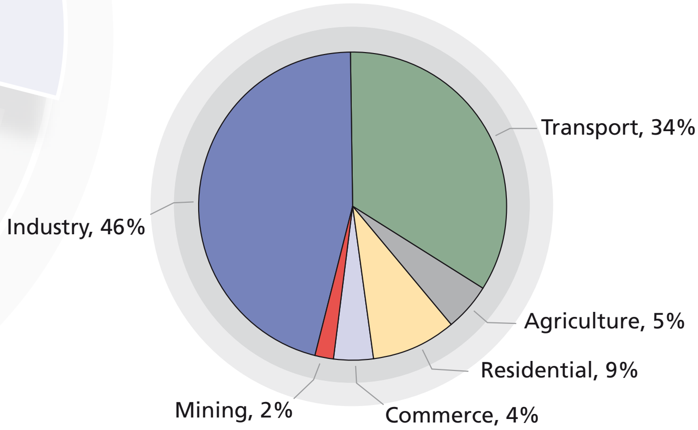


Figure 4-2: Western Cape energy use by sector (Draft Western Cape Integrated Energy Strategy, 2007)

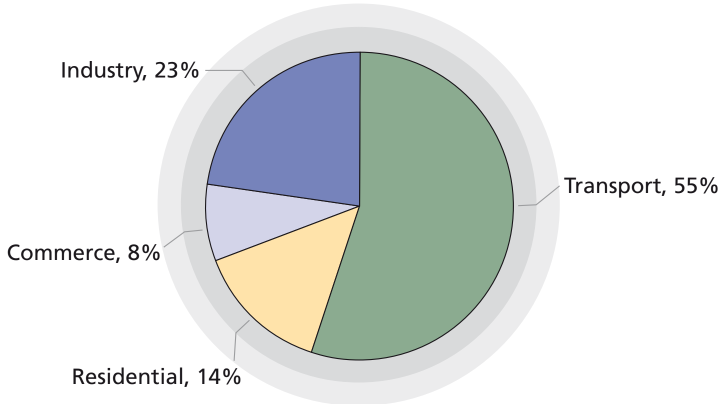


Figure 4-3: CCT energy use by sector (Cape Town Energy Futures, 2005)

4.1.2 Energy consumption by fuel type

The CCT is heavily dependent on fossil fuels, see Figure 4-6, with electricity (28%), petrol (26%) and diesel (17%) dominating the fuel mix. This is not very different to the overall fuel consumption by the metros in general; see Figure 4-5, where the electricity, petrol and diesel consumption is 32%, 26% and 15% respectively. The CCT fuel consumption mimics that of the province. Apart from biomass – firewood – the CCT relies exclusively on fossil fuels, and there is a growing acknowledgement of the need to diversify energy sources to ensure a sustainable economy.

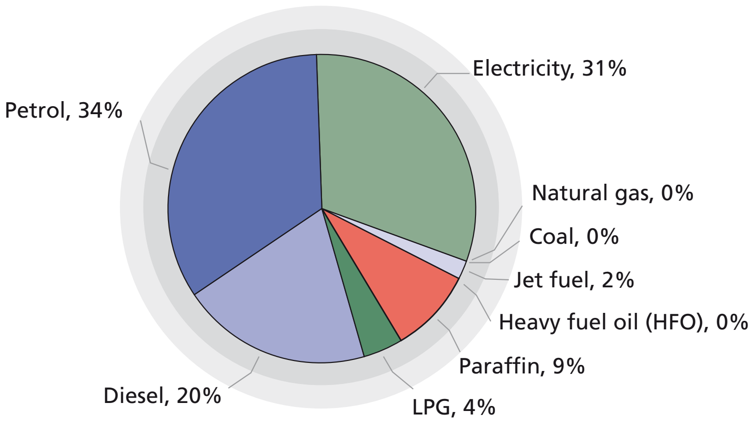


Figure 4-4: Western Cape energy use by fuel type (Draft Western Cape Integrated Energy Strategy, 2007)

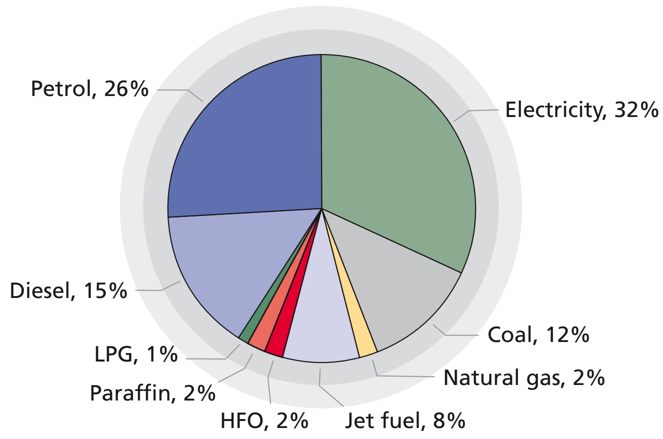


Figure 4-5: South African metros average energy use by fuel type (City Energy Review, 2006)

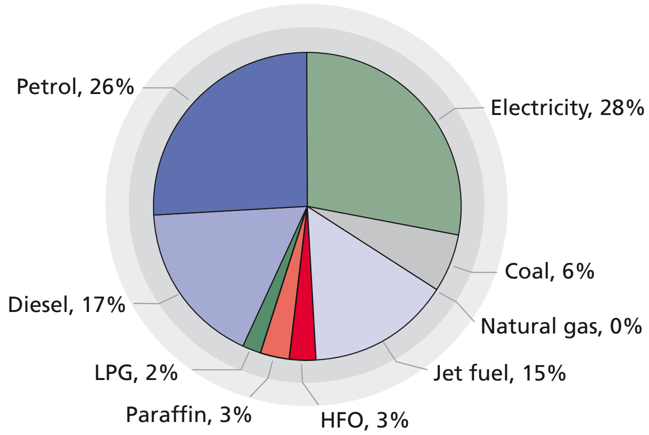


Figure 4-6: CCT energy use by fuel type (Cape Town Energy Futures, 2005)

4.2 Emissions profile

When referring to emissions we will be distinguishing between those that contribute to greenhouse gases (GHG) and those that negatively impact air quality. The GHG emissions are represented by carbon dioxide (CO_2) and are discussed with regard to sectoral and fuel contributions to these emissions. The emissions that affect the quality of health and the environment are discussed in the context of local air quality.

In general South Africa's six metros have an average carbon emissions level of 6.5 tonnes per person a year (Table 4-2). To put this into context, it is higher than the global average, but below the European and North American averages. Using relatively more diesel, petrol and electricity contributes significantly to the carbon emissions in the metros. A substantial contributor to the heavy carbon footprint is the reliance on coal-fired electricity. Local air quality has become an important area of environmental management for the metros but there is currently no uniformity in air quality monitoring, reporting and data collection.

Table 4-2: Metro CO_2 emissions per capita (City Energy Review, 2006)

	Population (million)	Total CO_2 emissions (million tonnes)	CO_2 per capita (tonnes)
South Africa	46.6	391	8.4
City of Cape Town	3.1	20	6.4
City of Johannesburg	3.6	20	5.6
City of Tshwane	1.7	14	8.1
Ekurhurleni	2.7	23	8.3
eThekwini	3.3	18	5.6
Nelson Mandela	1.0	5	4.7
Metro Total	15.4	99	6.5

4.2.1 Carbon emissions by sector

Understanding sectoral contributions to global emissions enables effective management for reaching target emissions reduction. Sector carbon emissions indicate that industry, transport and residential are the biggest contributors to carbon emissions both within the CCT and the Western Cape (Figure 4-8 and Figure 4-9). The overall cities data paints exactly the same picture, see Figure 4-7. The DME National Energy Efficiency Strategy (2005) addresses these three sectors and proposes interventions but implementation has been very limited.

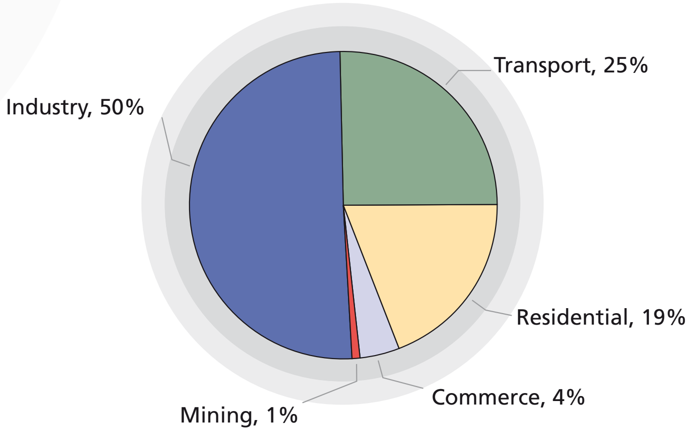


Figure 4-7: SA Cities carbon emissions by sector (City Energy Review, 2006)

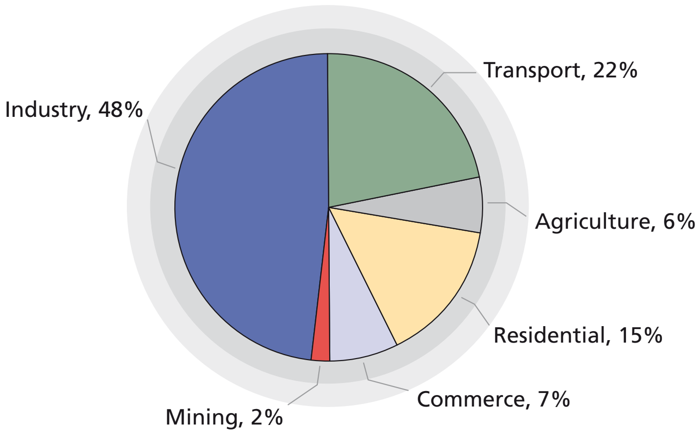


Figure 4-8: Western Cape carbon emissions by sector (Draft Western Cape Integrated Energy Strategy, 2007)

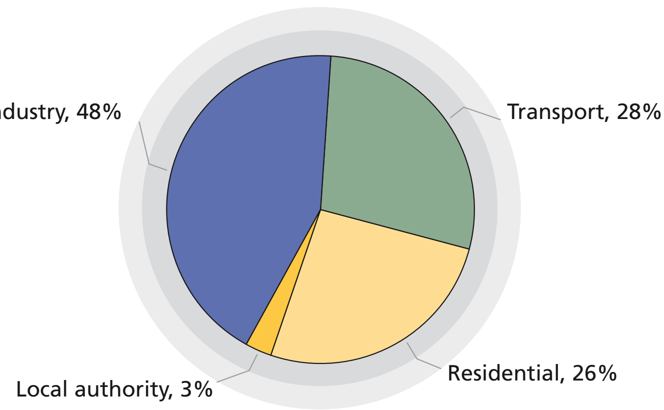


Figure 4-9: The CCT carbon emissions by sector (State of Energy in South African Cities, 2006)

4.2.2 Carbon emissions by fuel type

To provide a strategic approach to effective planning around sustainable fuel use it is vital to understand the emissions associated with each fuel type. Even though coal-fired electricity accounts for 31% of South Africa's cities energy consumption, electricity contributes to 66% of the total carbon emissions due to the low grade coal used for electricity generation (Figure 4-10). By contrast, petrol and diesel only make up 18% of the total metros carbon emissions even though they account for 41% of the total energy consumption within the metros (Figure 4-5). The emission profile for the Western Cape (Figure 4-11) is very similar to that of the CCT (Figure 4-12).

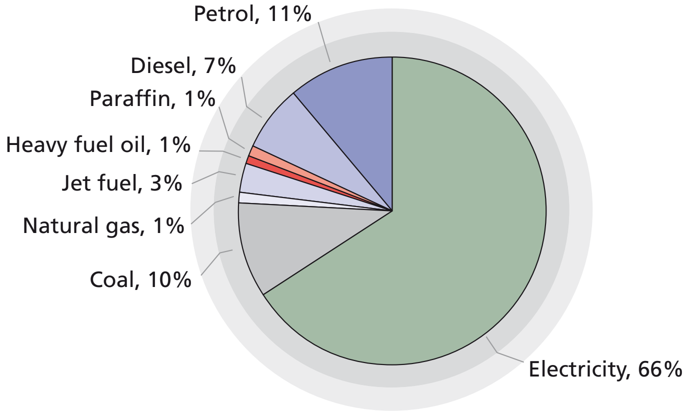


Figure 4-10: Metros carbon emissions by fuel type (City Energy Review, 2006)

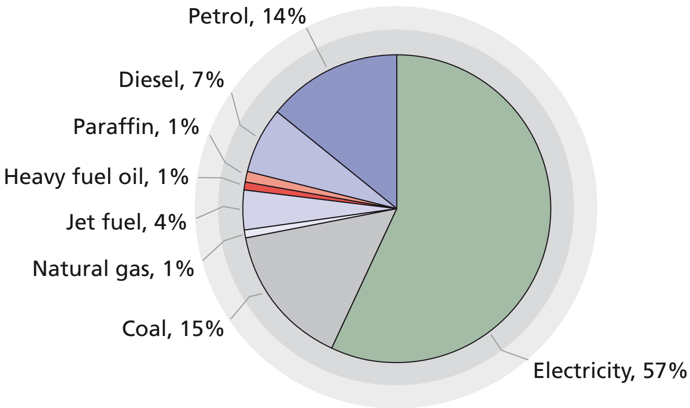


Figure 4-11: Western Cape carbon emissions by fuel type (Draft Western Cape Integrated Energy Strategy, 2007)

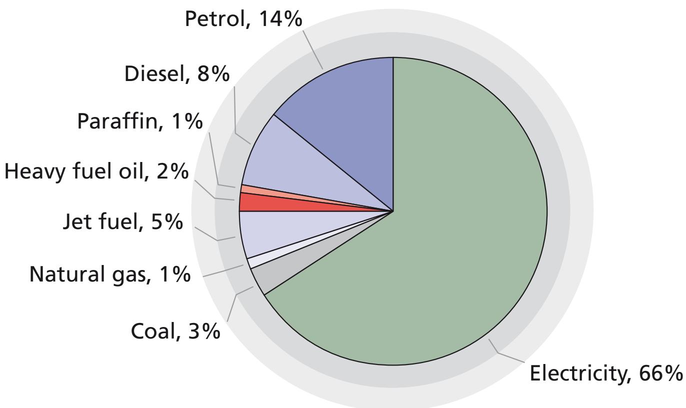


Figure 4-12: The CCT carbon emissions by fuel type (State of Energy in South African Cities, 2006)

4.2.3 Local air quality

Local emissions refer to those that affect the air quality in the city area and have direct local environmental and health impacts. These include nitrogen oxides (NO_x), sulphur oxides (SO_x), volatile organic compounds (VOCs) and particulate matter and are traditionally a direct result of fuel consumption. The National Environmental Management: Air Quality Act (39 of 2004) decentralised air quality management from the national to the local authority level. The Act requires that the local authority develop air quality management plans; all significant local emission sources are identified, quantified and addressed and that emission reduction and management planning is done by the owner of the emissions. The CCT has developed its Air Quality Management Plan in 2005 stating that the vision of the CCT is 'to be the City with the cleanest air in Africa'. This vision is to be achieved through the implementation of 11 objectives:

- To formulate an Air Quality Management System for the CCT;
- To specify ambient air quality standards and targets for the CCT;
- To monitor priority pollutants which cause the brown haze and affect human health;
- To improve air quality in informal settlements;
- To enforce current and future legislation for air quality management;
- To compile a source emission inventory database for the CCT;
- To control vehicle emission in the CCT;
- To consider air quality in land use and transport planning;
- To determine the extent of any detrimental health effects of poor air quality on the population of CCT;
- To establish a comprehensive education and communication strategy for air quality management; and
- To periodically review the air quality situation, report on progress and adjust and update strategies and objectives where needed.

The CCT experiences pollution levels that cause visible pollution (the 'brown haze') and in 2003 the air quality monitoring stations recorded 162 days of poor air quality, see Table 4-3. The pollutants that have been shown to exceed human health guideline values include; suspended particles smaller than 10 microns (PM_{10}), sulphur dioxide (SO_X), nitrogen oxide (NO_X), ozone (O_3), hydrogen sulphide (H_2S) and carbon monoxide (CO). These pollutants have been identified in the Air Quality Management Plan as posing significant health risks and have been prioritised in that it will be minimised.

Table 4-3: Pollutants measured to have exceeded guideline values at specific stations (grey shading indicates pollutant is monitored, the dot indicates occurrences where guidelines are exceeded) (CCT Air Quality Management Plan, 2005).

Station	PM_{10}	SO_2	NO_2	O_3	CO	H_2S
Athlone			•	•		
Bellville South	•	•				
Bothasig		•	•			•
City Centre	•		•	•	•	
Goodwood	•	•	•	•	•	
Khayelitsha	•					
Killarney	•	•	•			•
Table View	•	•	•			•

The CCT has a number of monitoring stations and a well established Air Quality Monitoring Network and through this poor air quality in informal settlements has been identified as being a major air quality issue. Khayelitsha, in particular was identified as an area where poor air quality is posing serious health risks. The CCT has started implementing the Khayelitsha Air Pollution Strategy (KAPS) to reduce air pollution and minimise health risks in informal settlements. If this project works it will be implemented in similar informal settlements throughout the CCT and the experience gained will be disseminated to other local authorities.

Khayelitsha Air Pollution Strategy

- Use community workers to conduct detailed survey of households, business, transport and other potential sources of air pollution.
- Compile a detailed emission inventory for the area.
- Workshop sustainable and economical interventions to reduce air pollution with the community.
- Pilot test interventions and monitor their effectiveness.
- Greening to be investigated to reduce pollution.

After industry, transport has been shown to be the biggest contributor to CO_2 emissions (Figure 4-6) and the Cape Town Brown Haze Study in 1997 (Wicking-Baird et al., 1997) attributed 65% of the brown haze to vehicular emission, of which 49% is caused by diesel vehicles and 16% by petrol vehicles. To date legislation controlling the emissions of vehicles is limited to smoke density testing of diesel vehicles.

Transport Planning and Vehicle Emission Strategy

- Support fuel reformation and motor vehicle emission control.
- Encourage the use of pool cars.
- Support the introduction of clean-burn technology.

In **summary** the Air Quality Management Plan (2005) outlines a range of strategies to reduce local pollutants, in order to improve air quality. Whether this process is effective will only be determined once regular reviewing of the air quality situation has been undertaken but the situation is optimistic with stakeholder and local authority involvement being positive.

4.3 Factors that affect energy demand

The demand for energy is a dynamic process and is most significantly affected by:

- Population growth
  - An increase in population results in an increase in the household consumption of energy thereby increasing the overall demand for energy.
- Economic growth
  - As the economy of the City grows more industries will be located within the CCT and associated with this is an increase in energy demand.
- Addressing the housing backlog
  - As the housing backlog is addressed the number of electricity connections will increase proportionally putting an additional demand on the grid for electricity, unless alternative fuel sources such as solar for water heating and LPG for cooking are used. If this process is managed well the additional demand for energy should not increase electricity demand significantly but fuel shifting can occur.

5 Residential demand for energy

Within the CCT the residential demand for energy comprises 14% of the total energy consumption (Cape Town Energy Futures, 2005). This chapter takes a closer look at what comprises the 14% and how population and economy of the CCT affects this demand.

5.1 Socioeconomic profile

The population within the CCT is approximately 3.2 million, or about 846 122 households (Table 5-1 and Table 5-2). This is 6.6% of the population of South Africa and the CCT contributes to 11.1% of the National Gross Value Add (GVA). In terms of housing, 82% of people in CCT live in formal houses while 18% live in informal dwellings (Table 5-3). The current housing backlog stands at 300 000 houses and it is estimated that this increases by 10 000 houses per year (CCT IDP 2007/2008).

Table 5-1: Summary demographic and socioeconomic data for the CCT (SACN, 2006)

Indicator	Data year	Value
Population	2005	3 239 768
Population as % of SA	2004	6.6%
Area	2001	2 499 km^2
Population density	2001	1 228 people/km^2
Population growth rate	2001 – 2004	6.1%
GVA[1]	2004	143 996 million Rands
GVA as% of National GDP	2004	11.1%
Cumulative GVA growth rate	2001 - 2004	2.5%

[1] Gross Value Add (GVA)

Table 5-2: Household and population numbers for the CCT (2007/ 2008 IDP's and Wesgro)

	Number	Comparative data
Households	845 000 in 2005 (IDP 2007/08)	798 227 in 2005 (Wesgro)
Population	3 239 768 in 2005 (IDP 2007/2008)	2 970 796 in 2005 (Wesgro)
% population below or marginally above the poverty line	38%	
% unemployment	20.7% in 2005 (IDP 2007/2008)	25% in 2005 (Wesgro)

Table 5-3: Dwelling profile for the CCT (Census, 2001)

Dwelling type	Number of hhs[1]	%
House or brick structure on a separate stand or yard	457 463	57.31%
Traditional dwelling/hut/structure made of traditional materials	15 191	1.90%
Flat in block of flats	77 497	9.71%
Town/cluster/semi-detached house	54 843	6.87%
House/flat/room in back yard	19 842	2.49%
Informal dwelling/shack in back yard	33 624	4.21%
Informal dwelling/shack not in back yard	113 110	14.17%
Room/flatlet not in back yard but on shared property	6 235	0.78%
Living quarters is not housing unit	20 422	2.56%
Total	798 227	100

[1] hhs - households

According to the 2007/2008 IDP for the CCT, decades of distorted development within the CCT has manifested in skewed distribution of income and wealth. In Cape Town there is a trend towards rising poverty (from 25% of households in 2001 living below or marginally below the poverty line to 38% in 2005) and unemployment (13% in 1997, 23% in 2001 and 20.7% in 2005). The finance and business services industry employs 21.5% of the formal work force within the CCT, followed by the wholesale retail and catering industry (Table 5-5). This indicates that the majority of the employed in the CCT are employed in the services industry.

Table 5-4: Household income profile per annum for the CCT (Wesgro, 2007)

Income (Rands)	Number of hhs	%
1 – 6 200	127 990	16.03%
6 201 – 11 500	67 889	8.50%
11 501 – 23 000	114 296	14.32%
23 001 – 47 000	134 528	16.85%
47 001 – 93 000	137 232	17.19%
93 001 – 185 000	112 549	14.10%
185 001 – 370 000	69 338	8.69%
370 001 – 745 000	23 841	2.99%
745 001 – 1 490 000	5 588	0.70%
1 490 001 – 2 980 000	3 090	0.39%
2 980 000 +	1 894	0.24%
Total	**798 234**	**100**

Table 5-5: Employment profile for the CCT (Census 2001)

Employment type	Population numbers	%
Agriculture, forestry, fishing	111 030	12.55%
Manufacturing	95 084	10.74%
Construction	63 986	7.23%
Wholesale, retail, catering, accommodation	143 297	16.19%
Transport, communications	32 818	3.71%
Finance, insurance, real estate and business services	189 959	21.47%
Community, social and personal services	21 228	2.40%
Other producers	93 959	10.62%
General government	128 658	14.54%
Total	**884 961**	**100%**

5.2 Residential energy consumption

Only 2% of households in the CCT area do not have access to electricity services[6]. However, 16% of City households do not have access to clean, safe, affordable and reliable energy services (State of Energy in South African Cities, 2006). The issue still remains around affordability of electricity to poor households and as a result most of the low income households use a variety of household fuels.

In the residential context energy is used primarily for one of the following activities:

- Lighting;
- Cooking; and
- Heating (space and water).

The total energy split between these three activities is shown in Table 5-6 and Figure 5-1 with the total energy consumption for the CCT being 21 605 308 GJ[7]. In excess of 50% of the residential energy consumption is used for cooking, 27% for water heating and 10% for lighting. Space heating uses only 1% of the total residential energy consumption. In contrast the electricity consumption scenario for middle to high income users differ significantly from the total consumption pattern as reflected in Figure 5.2., where water heating makes up 50% of the total consumption.

Table 5-6: Residential energy consumption by activity[8]

Cooking	Water heating	Refrigeration	Lighting	Space heating	Total
11 182 760 GJ	5 806 433 GJ	2 150 531 GJ	2 150 531 GJ	215 053 GJ	21 605 308 GJ

6 Cape Town Energy Futures Report, 2005
7 Integrated analysis for Cape Town's resource flows: Energy sector, SEA, 2007
8 Energy policies for sustainable development in South Africa, ERC, 2006

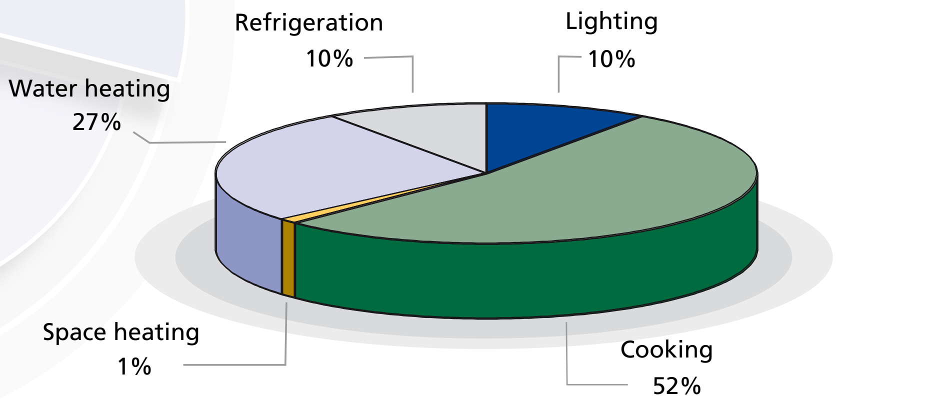


Figure 5-1: Residential energy consumption by activity[9]

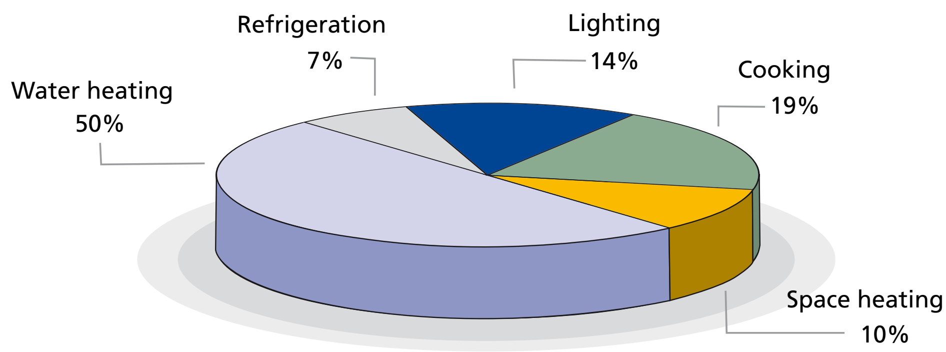


Figure 5-2: Middle – high income residential energy consumption by activity[10]

5.2.1 Household fuel mix

Middle and high income households in South African cities meet their energy needs almost exclusively through electricity (Winkler, 2005). The poorer households traditionally meet their energy requirements through a range of fuels that are costly from a health, economic and environmental perspective. In a study done by Annecke (2005), it was shown that in Khayelitsha around 20% of the monthly income is spent on energy (anything above 10% is defined as energy poverty).

The total residential energy consumption for the City is 21 605 308 GJ, a breakdown by energy source is given in Figure 5-3 and Table 5-7 below. The main energy source is electricity (83%) followed by paraffin (12%). Electricity consumption is attributed to middle and high income household use and paraffin to low income household usage.

Table 5-7: Residential energy consumption by energy source[11]

Electricity	Paraffin	LPG	Coal	Wood	Total
17 969 125 GJ	2 586 691 GJ	546 992 GJ	43 400 GJ	359 100 GJ	21 605 308 GJ

9 Energy policies for sustainable development in South Africa, ERC, 2006
10 Cape Town Energy Futures Report (SEA et al 2005)
11 Integrated analysis for Cape Town's resource flows: Energy sector, SEA, 2007

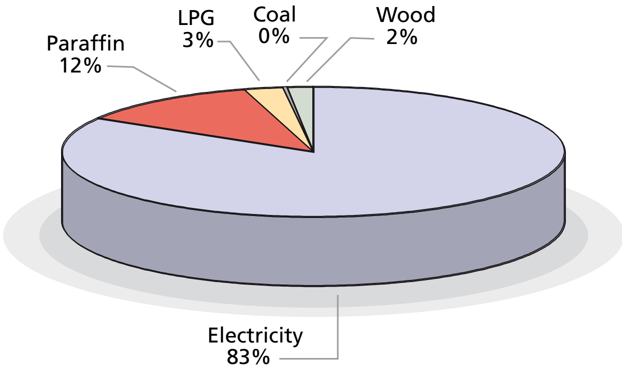


Figure 5-3: Residential energy consumption breakdown by energy source[12]

The residential energy mix per activity is shown in **Figure 5-3** below.

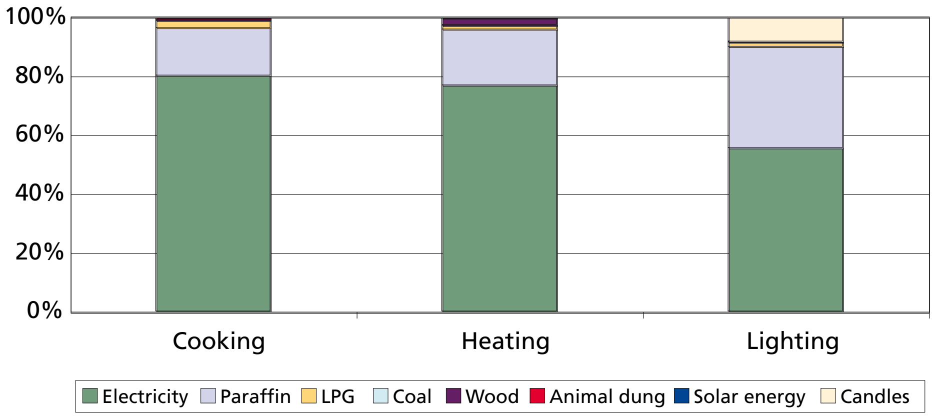


Figure 5-4: Household energy mix[13]

The majority of households within the CCT use electricity for cooking (80%), heating (75%) and lighting (56%). Low-income households use a mix of electricity, paraffin and gas, but paraffin is used extensively for all three activities with 34% of total households in the CCT using paraffin for lighting, 19% for heating and 16% for cooking.

5.3 Health and safety

Access to electricity is not always a given, even those households that are electrified cannot always afford the service. A study done in Khayelitsha (Annecke, 2005) noted that there were institutional difficulties in getting the electricity. Vendors were often too far away and often ran out of electricity themselves. In excess of 80% of households reported having difficulties in buying electricity, whereas very few households reported problems in buying or getting paraffin or LPG.

The use of energy sources has a range of health and safety issues associated with it. These include:

- Indoor air pollution;
- Households fires;
- Paraffin ingestion; and
- Electricity related accidents and fatalities.

5.3.1 Indoor air pollution

The use of paraffin and biomass fuels that are burnt indoors lead to high pollutants such as carbon monoxide, particulate matter and other organic compounds in the living environment. Exposure to indoor air pollution has been associated with a number of health outcomes, most notably, Acute Lower Respiratory Infections (ALRI) such as pneumonia amongst children less than five years old (MRC, 2004). Despite this, no systematic household air pollution monitoring is in place within the CCT.

12 Integrated analysis for Cape Town's resource flows: Energy sector, SEA, 2007
13 State of energy in South African Cities, SEA, 2006

5.3.2 Household fire incidences

The scenario below is a reality for thousands of Cape Townians living in informal settlements. Data is available on fire inidences for both electrified and non-electrified households within the CCT, this is given in Table 5-8 below.

'Imagine that you and your family are fast asleep, when the sound of cracking flames, the smell of thick smoke and the sight of engulfing balls of fire suddenly snatch your sleep away in the middle of a cold night. Imagine the fire is decimating your hard-earned wardrobes, beds, mats, building materials, consuming all your clothes, valuable documents like your identity document, certificates, cash, blankets and everything. Imagine, realising that your toddler did not make it and perished in the destruction. Whilst you are imagining, realise that this reality for thousands of poor people who use paraffin and paraffin appliances daily. As much as the destruction's impact to the economy can be quantified to R104 billion rand per annum, its real impact on human life is not quantifiable' says the Managing Director of the Paraffin Safety Association, Patrick Kulati.

Table 5-8: Incidences of fires in informal settlements in CCT (PASASA, 2007)

Year	Fires	Structures	Death
2003	1 437	?	?
2004	1 161	?	?
2005	1 327	8 693	112

The number of fires per annum from 2003 to 2005 has not varied considerably. In the CCT death by burns (not only burns due to dwelling fires) features as the 5th most common external cause of death, as opposed to 7th most common cause of external death in the other three cities. Death by burns is a high priority issue in the CCT and causative factors have been linked to fuel-related burns, geographical and seasonal factors such as the hot, dry and windy conditions prevalent in Cape Town's summer season and fuel use patterns.

5.3.3 Paraffin ingestion amongst children

One of the most common causes of childhood unintentional poisoning is paraffin ingestion. Paraffin is very viscous and leads to chemical pneumonitis and eventually pneumonia when it gets into the lungs. The most recent paraffin ingestion statistics are from 2004, in Table 5-9. The data presented in Table 5-9 is based on estimates calculated by experts and provides an estimation of the problem. The CCT has the second highest number of incidences of paraffin ingestion after eThekwini. This can be attributed to the fact that the majority of poor households in the CCT use paraffin extensively for the full range of energy utilising household activities. There is no accurate and reliable data available that can shed more light on this issue, however the Paraffin Safety Association of Southern Africa (PASASA) is currently underway with the implementation of a national Geographic Information System (GIS) surveillance system, that will capture and collate such information[14]. Studies[15] have shown that the majority of paraffin poisoning incidences are amongst children in informal and rural areas.

Between 40 000 to 60 000 children in South Africa suffer from paraffin ingestion each year. It is estimated that every year between 171 and 498 of the children treated in South African hospitals cannot be saved. The majority of victims are under the age of five. (Paraffin Safety Association of South Africa).

Table 5-9: Estimated incidences of paraffin amongst children in the metros and related costs[16]

City	Number of Incidences	Weighted Average Treatment Cost (Rands)
Buffalo City	1 126	459 262
City of Cape Town	2 033	829 572
City of Johannesburg	880	359 170
City of Tshwane	1 257	513 019
eThekwini	3 765	1 536 077
Nelson Mandela	694	283 109

Paraffin ingestion is placing a considerable economic burden on the poor and marginalised communities where the majority of poisoning incidents and deaths occur.

14 Personal communication with Dehran Swart from PASASA
15 Study by Matzopoulos and Carolissen (2006)
16 This estimation is based on work by Yach (1994)

5.4 Comparison with 2003 State of Energy (SoE) Report

Table 5-10: Household statistics comparison

	2003 SoE	This report	Change
Number of households	800 000	845 000	5.7%
Population	315 4000	323 9768	2.7%
Unemployed	19.4%	20.7%	6.7%
Residential energy usage as percentage of total energy usage	15%	14%	-6.7%
Total household electricity usage as percentage of total energy electricity usage	38%	28%	-26.3%
Households without access to electricity	5%	2%	-60.0%

The 2003 data is from the 2003 State of Energy Report

The number of households, percentage unemployed and percentage of households without access to electricity have shown typical trends expected within the metro. Most noticeable is the decrease in the percentage of households that use electricity as opposed to other energy sources. The data used for this report is based on residential usage figures for the 2006 calendar year and the difference can be attributed to:

- The fact that the increase in the number of households has been predominately in the low income communities where electricity is not the primary energy source;
- The beginning of the 'energy crisis' in the Western Cape with the result that the use of electricity was drastically decreased by proactive steps taken by consumers to reduce their electricity consumption;
- The rollout from ESKOM of CFLs and geyser blankets; and
- The issuing of gas stoves.

6 Industrial and commercial energy demand

6.1 Overview of industrial and commercial activity in the CCT

The economy of Cape Town contributes 82% to the gross geographic product (GGP) of the Western Cape. From 1994 to 2004 Cape Town contributed 15.9% of South Africa's gross domestic product (GDP). In 2005 Cape Town's contribution declined to 11.1%. Cape Town has a relatively diverse economy with approximately 93% of Cape Town businesses being small, contributing 50% of total output and 40% of total formal employment. The share that each sector contributed to the gross geographic product (GGP) and to employment in 2005 is given in Table 6-1.

Table 6-1: The contribution of each economic sector to the GGP of Cape Town and the number of people employed per sector[17]

Economic sector	GGP (Rm current prices)	% of total GGP	Employed (number)	%
Agriculture, forestry and fishing	2 036	1%	111 030	16%
Mining	186	0%	740	0%
Manufacturing	26 521	18%	95 084	14%
Electricity and water	2 608	2%	4 203	1%
Construction	4 464	3%	63 986	9%
Wholesale and retail trade; catering and accommodation	25 750	17%	143 297	21%
Transport and communication	16 258	11%	32 818	5%
Finance and business services	47 442	32%	189 959	28%
Community, social and other personal services	7 989	5%	21 228	3%
General government services	15 387	10%	12 118	2%
Total	**148 641**	**100%**	**67 4463**	**100%**
GGP per capita	50 034			

The economy of the CCT relies heavily on the trade and service sectors (tertiary sector), although the manufacturing sector's contribution to GGP is highest at 26.2% to the total. However, it is the tertiary sector, which includes the finance, real estate, trade and catering and services sector combined, which generates 58% of the GGP. This sector also provides employment to the majority (55%) of the 1 026 043 economically active population.

Manufacturing and other secondary activities (electricity, water, construction, transport and communication) are also significant contributors to employment (43%). The primary sector activities do not play a significant role in the GGP or employment creation compared to the secondary and tertiary sectors.

The economy of the Western Cape shows similar characteristics with the contribution of secondary and tertiary sectors to gross value added to the economy of the City of Cape Town. The only marked difference is the Western Cape's higher contribution (6.3%) of the primary sector to the economy from agriculture, forestry and fishing as compared to the lower figure of 0.9% for CCT. This is probably a result of the contribution of the Plattleland municipalities of the West Coast, Winelands/Breede River, Overberg and Karoo, which form part of the Western Cape.

Table 6-2: Sector contributions to Value Added to economy[18]

Sectors	City of Cape Town (%)	Western Cape (%)	South Africa (%)
Primary	0.9	6.3	10.9
Secondary	27.6	26.7	26.5
Tertiary	71.5	67.0	62.6
Total	**100**	**100**	**100**

The largest number of industries and commercial areas are situated in the Cape Town municipal local council.
The major industrial areas are in:

- Epping
- Montagu Gardens
- Retreat / Wynberg
- Blackheath / Blue Downes
- Paarden Eiland
- Atlantis
- Salt River
- Phillipi East
- Bellville / Stikland

[17] Data obtained from Wesgro
[18] Data obtained from Wesgro

6.2 Energy demand

In Cape Town, industry and commerce consume 31% of total net energy use. This is low compared with the figure of 50% for the Western Cape and the 46% for the country, indicating that the CCT has a much less energy intensive economy on average. Commercial energy usage accounts for 8% of the total in this sector and industry 23%. The energy consumption per capita is an interesting indicator to give an idea of how efficient energy is being utilised to the economic advantage of the City. This data is given in Table 6-3. It is apparent that the CCT consumes less energy for a higher economic output than the national cities average. This is due to the nature of economic activity within the CCT, which is primarily in the tertiary sector.

Table 6-3: Energy and electricity consumption per capita[19]

	Energy consumption per capita (GJ/annum)	Electricity consumption per capita (GJ/annum)
South Africa	58	18
City of Cape Town	44	14
City of Johannesburg	37	13
City of Tshwane	55	17
City average	53	17

6.2.1 Sectoral energy demand

The total energy usage by commerce and industry for the 2006/07 year was 31 711 702 GJ. Commercial use is mostly electricity for lighting and air-conditioning in offices, shopping malls, hotels, etc. There are several large secondary industries within the CCT and their energy needs vary considerably as the industries range from foundries, metal finishing and electroplating industries and from fish processing to textiles/nylon spinners and glass works.

Table 6-4: Electricity consumption by commerce and industry (data obtained from the CCT)

Customer category*	Total GJ per year
Commercial – small	5 803 926
Large and very large	15 760 030

* as per the CCT tariff categories

The bulk of electricity usage in the commercial sector is in office blocks followed by hospitals and office blocks, see Figure 6-1.

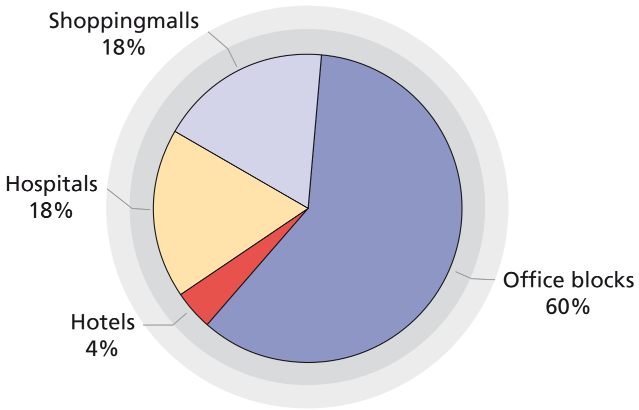


Figure 6-1: Electricity consumption by commercial sector

A breakdown of energy usage in the industrial sector is given in Figure 6-2. These numbers should be interpreted with caution and should be used to give a high level picture of the industrial energy usage as industrial energy consumption and fuel used are not well monitored.

19 State of energy in South African Cities, SEA, 2006

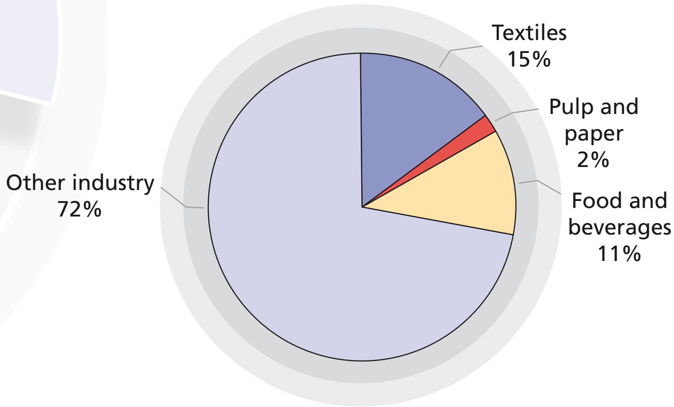


Figure 6-2: Energy consumption by industrial sector

The informal sector is significant in terms of economic output (12% of GGP) and employment (18% of total) but detailed information on the energy needs are not readily available.

6.2.2 Fuel usage

Electricity accounts for 68% of the entire commerce and industry sector energy consumption. Heavy furnace oil accounts for 15% followed by coal at 12%. The remaining fuels – paraffin, LPG, diesel and wood – play minor roles. Commercial and industrial energy breakdown by fuel source is given in Figure 6-3 and Figure 6-4 respectively.

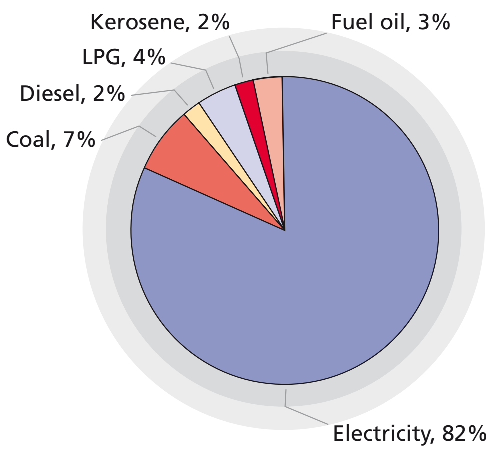


Figure 6-3: Commercial fuel breakdown

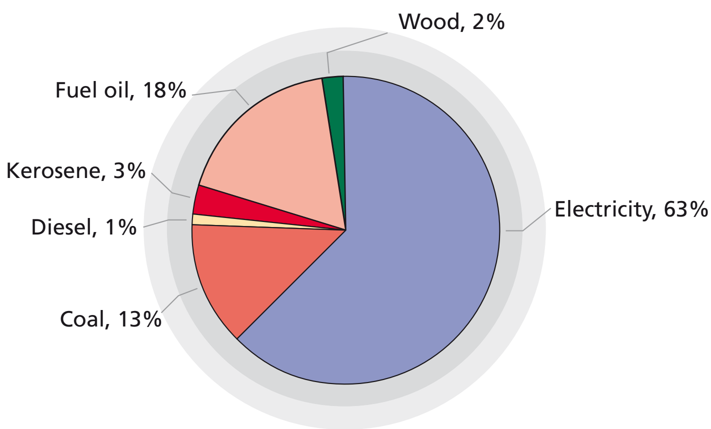


Figure 6-4: Industrial fuel breakdown

6.3 Summary of trends

Electricity is the primary energy source in the commercial (63%) and industrial sector (82%). This is because there has been little incentive to move towards energy efficiency practices, due to the low cost of electricity in South Africa. Being the largest energy conduit in the CCT it is also responsible for the vast majority of CO_2 emissions. The primary activities in the commercial sector that contribute the electricity consumption are lighting and air conditioning. The energy usage, when viewed against the economic model is higher than the national and cities average due to the tertiary nature of the economic activity within the CCT.

6.4 Comparison with 2003 State of Energy (SoE) Report

The nature of the industrial and commercial sector in the CCT has not changed over the last four years. The energy consumption patterns have mimicked this, with a slight decline (2%) in energy usage being realised. This decrease can be attributed to energy efficient measures that are currently implemented and that are gathering momentum.

6.5 Recommendations

Improved construction methods, as well as the use of technologies to enhance energy efficiency in industry and commerce will increase CCT's competitive advantage internationally. There is a pool of existing experience in innovative technologies and programmes for energy efficiency and demand side management. Eskom's DSM programme (www.eskomdsm.co.za) has focussed on three key areas:

- Load management;
- Industrial equipment; and
- Efficient lighting.

The interventions typically include load management (carried out by the utility) and energy efficiency improvements normally carried out by the end user. In the industrial sector various measures can be undertaken to realise energy savings.
These measures are[20]:

- **Variable speed drives:** These drives reduce unnecessary power consumption in electrical motors with varying loads. The typical payback period is 3.6 years and 2.2% of industrial electricity can be saved.
- **Efficient motors:** Efficient motors can reduce power consumption. The typical payback period is seven years and 2.3% of industrial electricity can be saved.
- **Compressed air management:** This measure is easily achieved and often results in significant savings at low cost. The typical payback period is 0.9 years and 3.2% of industrial electricity can be saved.
- **Efficient lighting:** These measures take advantage of natural lighting, more efficient light bulbs and appropriate task lighting. The typical payback period is 3.6 years and 1.9% of industrial electricity can be saved.
- **Heating, ventilation and cooling:** These measures are for maintaining good air quality and temperature and can be achieved through better maintenance and the installation of appropriate equipment. The typical payback period is 2.2 years and 0.6% of industrial electricity can be saved.
- **Thermal savings:** Thermal saving refers to more efficient use and production of heat. For steam systems in particular options like condensate recovery and improved maintenance must be implemented. The typical payback period is 0.8 years and 1.4% of industrial electricity, 10% oil and 15% coal can be saved.

Within the commercial sector the following energy efficiency interventions are proposed:

- New building thermal design: A new building design must significantly reduce energy consumption by the following measures:
  - Optimisation of thermal mass for local climate
  - Optimal insulation
  - Glazing
  - Correct orientation
  - Building shape;
- Retrofitting air conditioners;
- Efficient lighting systems; and
- Solar water heating.

Clear signals are needed to induce industry to take more responsibility for their contribution to climate change and carbon emissions and their ability to change this. The agreement between industry and government to implement the energy efficiency strategy[21] and the recent announcement that a dedicated Energy Efficiency Agency will be established both bode well in this regard. In the commercial sector a strong legal (national) and institutional framework is needed to implement the energy efficiency measures. The CCT has taken the lead here by embarking on a programme to make its own buildings and practises more efficient.

[20] **Energy policies for sustainable development in South Africa, ERC, 2006**
[21] **Draft Energy Strategy for the Republic of South Africa, DME, 2004**

7 Transport energy demand

Transport has a distinctive characteristic of its own, and within the CCT it is responsible for 55% of the total energy usage. This section provides a peek into the urban transport energy situation within the CCT.

7.1 Modal split

Cape Town's current public transport sector is comprised of three modes – commuter trains, buses and minibus taxis. The commuter train network in Cape Town is the most extensive of any city in South Africa. It carries the largest proportion of public transport users and remains the backbone of the system, despite severe under funding of maintenance leading to declining services.

Table 7-1: Key transport system characteristics

Metropolitan road network (freeway, arterial, and main routes)	Approx. 2235 km
Local road network	Approx. 7513 km
Number of private vehicles	600 000
Car ownership per 1 000 population	200
Bus fleet	1318
Number of bus routes (subsidised and not subsidised)	1545
Rail fleet (number of revenue train sets operational)	78
Total length of rail track	581 km
Number of stations	119
Minibus fleet	7467
Number of minibus routes	565
Number of minibus taxi owners	6359
Metered taxi fleet (Sedans)	567
Modal split: home to work (am peak period) (% private: public: non-motorised)	46: 42: 12
Modal split: public transport modes (% rail: bus: minibus taxi)	54: 17: 29

The percentage breakdown by mode of transport is shown in Figure 7-2. Nearly 54% of commuters that travel by motorised transport to work or school do so by private car (See Table 7-2 and Figure 7-2). The rest use public transport, and are traditionally settled far from opportunities and facilities. In excess of 30% of the CCT commuters walk to school or work (See Figure 7-3). Most of those walking to work are not doing so because of proximity but are doing so to save on the cost of public transport.

Based on a projected economic growth rate of 5% for the CCT and a projected population growth rate of 3% per annum, it is assumed that the average daily number of commuters is projected to increase at a rate of 4% per annum. This rate of increase in commuters represents a cumulative increase of close to 50% (see Table 7-2) over the next 10 years and providing for this level of commuting and the associated pollution in the City presents a major challenge.

Table 7-2: Modal split - trends

Transport Mode	No. of commuters (thousands per day)		Cumulative increase
	2004/05	2014/15	(11 yrs)
Rail	602	908	51%
Bus	197	312	58%
Taxi	332	446	34%
Private car	1 100	1 636	49%
Total	2 231	3 302	48%

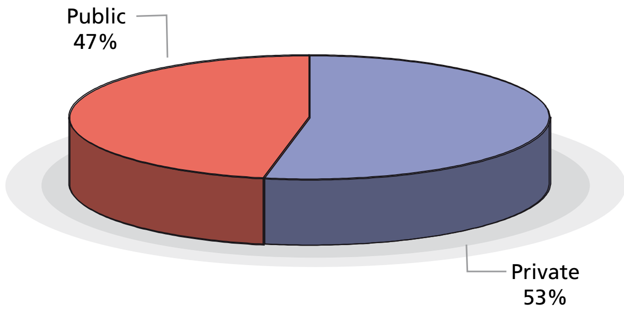


Figure 7-1: Transport split between public and private

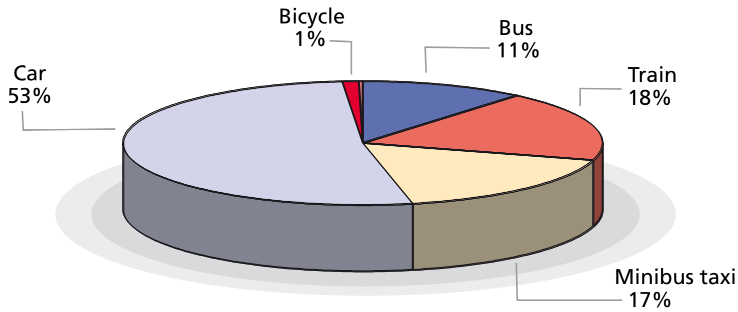


Figure 7-2: Split by mode of transport

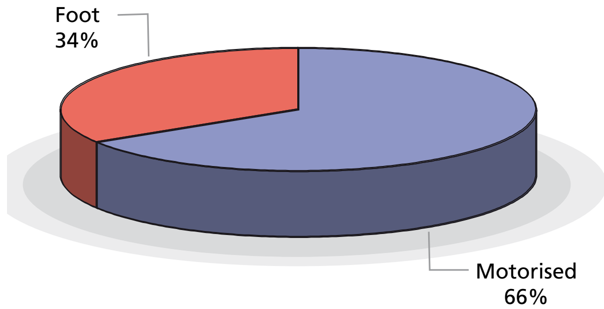


Figure 7-3: Split between motorised transport and transport by foot

There is a strong link between income and mode of transport making investment in non-motorised conditions and public transport an important aspect of poverty alleviation. Typically the low-income communities primary mode of transport is walking and as income increases walking is initially replaced by public transport and ultimately by private vehicles.

7.2 Energy demand

In 2006, the transport sector in Cape Town consumed 61 794 299 GJ of energy, which was approximately 39% of the final energy demand. Of this 41 138 766 GJ was petrol, 13 762 864 GJ was diesel and 6 892 669 was jet fuel. A breakdown of the liquid fuel consumption is shown in Table 7-3. The bulk of the liquid fuel usage is by the private commuter (these include minibis taxis).

Table 7-3: Liquid fuel consumption in the transport sector

	Petrol (ℓ)	Diesel (ℓ)	Jet Fuel (ℓ)
Public transport	82 185	27 620 542	n/a
Private	1 201 510 715	257 908 310	n/a
Road haulage	1 294 982	62 36 370	n/a
Transnet	n/a	8 655 650	178 566 542
Total (l)	1 202 887 882	356 550 872	178 566 542
Energy (GJ)	41 138 766	13 762 864	6 892 669

Data obtained from Calref

An indication of the energy consumption characteristics of the different modes of transport is shown in Table 7-4. It is evident that the use of private cars contributes extensively to the energy consumption within the transport sector.

Table 7-4: Energy consumption of different transport modes[22]

Mode	Relative energy consumption per seat (km)
Motorcar	0.29
Bus, mixed traffic	0.12
Bus, Busway	0.09
Rapid rail transit	0.15

7.3 Summary of transportation trends

The metropolitan area of Cape Town is facing mounting challenges in the transportation of people and goods within its boundaries. The majority of the City's 3.2 million people are dependent upon public transport; yet this is generally overcrowded at peak times, and often unsafe, inconvenient, and increasingly unreliable. This, coupled with growing personal wealth, is resulting in a switch to private motor cars leading to increasing road congestion, negatively affecting public and private transport. There is also a significant adverse environmental impact. The trends are unsustainable as assets deteriorate and inefficiencies worsen. The impact that this scenario will have on the energy picture within the CCT is undesirable.

One of the key issues that the sector is faced with is that many of the transport functions are not the responsibility of the CCT. The City is responsible for the management of urban space, including the overall planning function. However, there are some crucial components where responsibility lies with other governmental departments. The fragmentation in authority that this engenders substantially undermines the scope for integrated, strategic management and subsequently the environmental impact of this situation cannot be remedied easily.

There are a range of initiatives currently underway as part of the City's Mobility Strategy that will ultimately aim to redress the impact that the transport sector has on the energy picture of the CCT. These initiatives include:

- Development of nine city-wide transport corridors in line with the Mobility Strategy; the Klipfontein Corridor being the first of a phased corridor programme;
- Provision of dedicated public transport lanes and priority systems on transport corridors as appropriate;
- Transport support to flagship urban renewal projects such as the N2 Gateway project;
- Implementation of transport system management, travel demand management and intelligent transport systems (including area traffic control);
- Promotion of cycling through provision of cycle routes, facilities, and storage facilities aimed at enhanced safety and convenience;
- Promotion of walking by providing and maintaining pedestrian footpaths and walkways which are safe, convenient, pleasant and well illuminated; and
- Integration of non-motorised networks with public transport networks.

7.4 Comparison with 2003 State of Energy (SoE) Report

The data presented in the SoE 2003 report was based primarily on 1999 data and consequently the picture presented was very different to that given here. A comparison is thus not appropriate.

[22] **State of energy in South African Cities, SEA, 2006**

8 Local authority

The City controls, or has a direct impact, on a host of functions and activities. It is responsible for providing services to a population of approximately 3.2 million people. It is the single biggest energy user in the CCT and the single biggest employer, employing 24 000 staff members.[23]

8.1 Energy demand

The CCT's main functions which use energy include:

- Bulk water supply;
- Waste water;
- Operation of numerous office buildings and workshops;
- Street lighting;
- Fleet operation (7 728 vehicles); and
- Provision of electricity.

The primary energy sources used by the CCT are electricity and diesel as shown in Figure 8-1. Electricity contributes to 41% of the total energy consumption by the local authority but accounts for 63% of the CCT's total energy cost. Petrol and diesel account for 8% and 29% of the CCT's total energy cost.

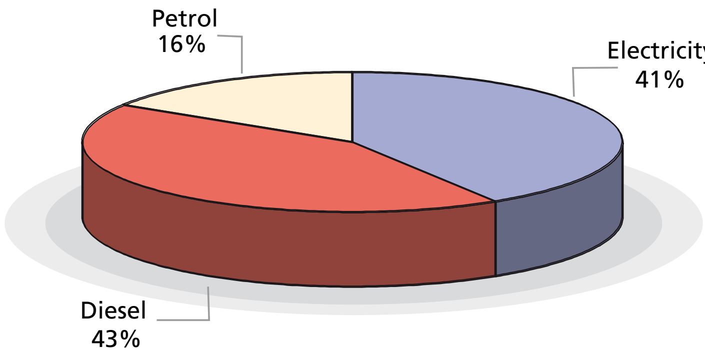


Figure 8-1: Local authority energy use by fuel type

The electricity usage profile within the CCT is shown in Figure 8-2. The major electricity consuming activities are streetlighting and the buildings.

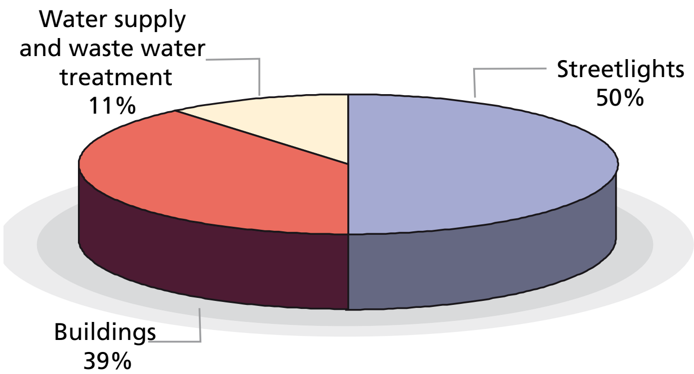


Figure 8-2: Local authority electricity consumption

[23]**Energy and climate change strategy, CCT, 2006**

8.1.1 Summary of sectoral trends and recommendations

The CCT spends over R100 million per annum on electricity, diesel and petrol consumption. Energy efficiency measures would therefore result in a substantial financial benefit for the CCT. Various options have and are being considered by the CCT in an attempt to reduce the burden being placed on the energy landscape. These options include:

- Efficient lighting (buildings, street and traffic lights).
- Efficient electrical appliances (computers, printers, fax machines, refrigeration, etc.).
- Efficient heating and cooling systems and processes.
- Improved management of both the petrol and diesel fleet to ensure greater efficiency.
- Aeration efficiency and variable speed pumps at water supply and treatment works.
- Improved construction of new buildings as well as consideration of improved efficiency in the retrofit and renovation of existing buildings.
- Consideration of renewable energy consumption and use (waste to methane gas, waste to energy, sewerage gas energy generation).

The potential financial and environmental savings that can be realised by these interventions are given in Table 8-1.

Table 8-1: Summary of total identified energy savings potential within the CCT operations[24]

Energy source	Savings method	Rand savings per annum	CO_2 savings per annum
Petrol fleet	Improved management	2 642 000	1 943 tonnes
Diesel fleet	Improved management	5 825 000	5 688 tonnes
Building electricity use	Lighting efficiency	2 792 000	13 354 tonnes
Water supply and treatment electricity use	Aeration efficiency and variable speed pumps at water supply and treatment works	1 039 000	4 970 tonnes
Street/traffic light electricity use	LED traffic signal retrofit	595 000	2 844 tonnes
Total		**12 893 000**	**28 799 tonnes**

An example of where the building energy efficiency interventions have been successful is at the municipal building in Parow.

The CCT reduced the electricity bill in the Parow municipality by 22% through the following measures:

- Efficient lighting (CFLs);
- Solar water heater installation; and
- User behaviour around air conditioning.

[24] Energy and Climate Change Strategy, CCT, 2006

9 Energy supply overview

This section provides a contextual overview of energy supply to the CCT in relation to the country and the province.

9.1 Contextual overview

9.1.1 National context

South Africa has a well-developed energy supply and production system. The South African energy sector is dominated by coal which is abundant and relatively cheap by international standards. Most of South Africa's liquid fuel requirements are imported in the form of crude oil. Approximately 35% is sourced from coal through Sasol and 100% of the natural gas production from PetroSA is converted into liquid fuels, supplying about 7% of liquid fuel requirements. Renewable energy comprises biomass and natural processes that are replenished and can be used as an energy source. Biomass is used commercially in the pulp and paper mills and sugar refineries by burning bulk from logs, black liquor and bagasse to produce process heat. In households, biomass is used for cooking and heating. Biomass is estimated to comprise 8% of South Africa's primary energy supply. Only a small portion of this primary energy is consumed directly; the rest goes through processes of energy transformation, which change it into other forms of energy, namely electricity and liquid fuels. The total primary energy supply of for South Africa is shown in Table 9-1.

Table 9-1:Total primary energy supply (2004 data)*

	Total Energy Supply (TJ)	%
Coal	3 573 343	68.2
Crude oil	1 016 664	19.4
Gas	84 152	20.1
Nuclear	145 801	2.8
Hydro	2 890	0.1
Renewables	418 058	8.0
Total	5 240 908	100

***Data obtained from DME**

The two most important conversions of primary energy in South Africa are the generation of electricity and the production of liquid fuels. South Africa generates over half the electricity used on the African continent.[25] There are three groups of electricity generators:

- Eskom;
- Municipal generators; and
- Industries that generate electricity for their own use.

Of these groups Eskom has 91% of the total generating capacity, the municipalities 5.6% and autogenerators 3.1%.

The primary issues that South Africa is faced with in terms of energy supply are:

- Energy reserves and prices; and
- Electricity supply
  - South Africa is rapidly running out of generation capacity and is the process of commissioning the building of new power stations.

9.1.2 Provincial context

The Western Cape currently relies heavily on coal produced electricity and on petrochemicals for its energy supply. This is consistent with the rest of the country, where 90% of the electricity supply is derived from coal.

The Western Cape buys most of its electricity from Eskom, much of which comes from coal generated energy plants elsewhere in the country (predominantly from Mpumalanga). However, a portion of our electricity is generated locally, including energy from the Koeberg Nuclear Power Plant, the Acacia Gas Turbines, the Palmiet Pumped Storage Facility and the Klipheuwel Demonstration Wind Farm. The City of Cape Town also produces a small amount of electricity through the Steenbras Pumped Storage Facility and local gas turbines. Although Eskom has line strengthening plans in place to help secure electricity for the Western Cape, there are a range of other options that may be preferable, including diversifying the supply mix and broadening the energy generation options.

[25] **Energy policies for sustainable development in South Africa, ERI, 2006**

9.1.3 City of Cape Town context

A geographic representation of the energy supply centers is shown as Figure 9-1 and the energy sources and associated CO_2 emissions is given in Table 9-2. The primary energy source for the CCT is electricity followed by petrol and is consistent with the national and provincial situation.

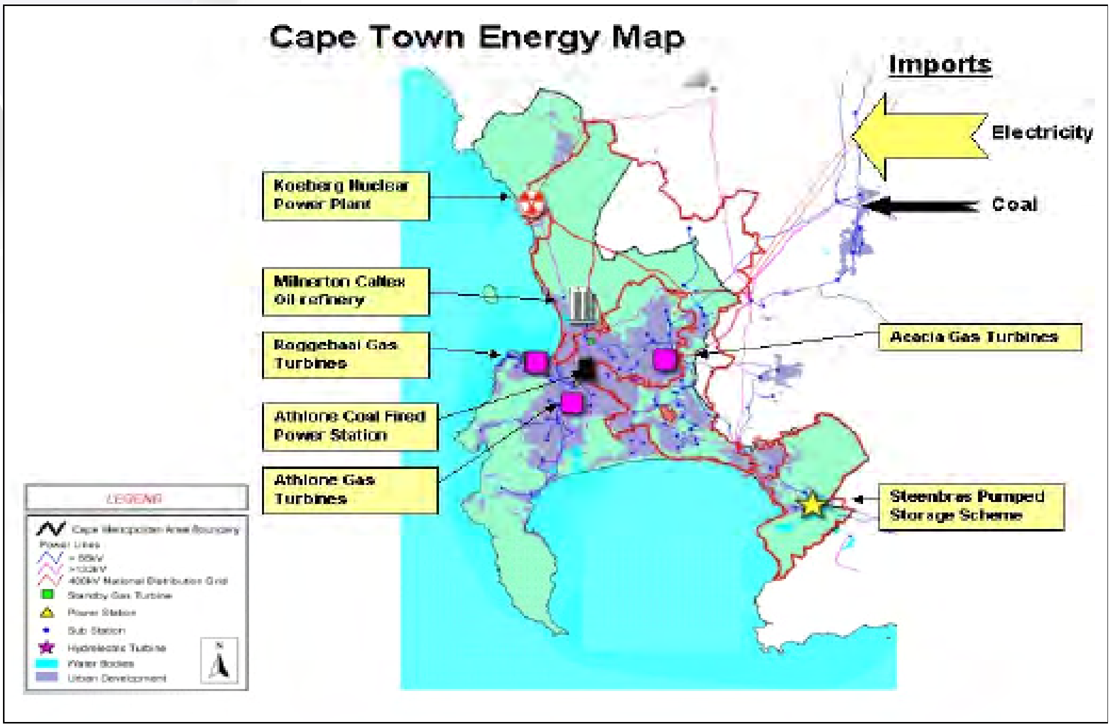


Figure 9-1: CCT energy map[26]

Table 9-2: CCT energy sources and associated CO_2 emissions[27]

Fuel	GJ/yr	%	CO_2 tonnes/yr	%
Electricity	36 835 284	33%	11 256 863	68%
Paraffin	2 448 796	2%	175 579	1%
LPG	684 970	1%	43 153	0%
Coal	3 831 352	3%	361 680	2%
Petrol	40 687 369	37%	2 815 566	17%
Diesel	20 127 757	18%	1 487 441	9%
HFO	4 695 842	4%	362 519	2%
Wood	920 417	1%	0	0%
TOTAL	110 231 787	100%	16 502 801	100%

9.2 Energy supply options

At present the CCT is heavily dependent on electricity to supply the bulk of its energy requirements. There are a number of ways in which the energy supply to the CCT could be increased and diversified, ensuring energy security and promoting clean, renewable energy sources.

26 State of Energy Report, CCT, 2003
27 State of energy in South African Cities, SEA, 2006

9.2.1 Electricity

Eskom sells electricity in bulk to the City of Cape Town, who then distributes it. This accounts for approximately 72.5% of electricity sold in the metro. The remaining 27.5% is supplied and distributed by Eskom. It is noteworthy that in terms of domestic users, the split between CCT and Eskom is 60% to 40%, indicating that Eskom provides electricity to mostly low income and low energy users.

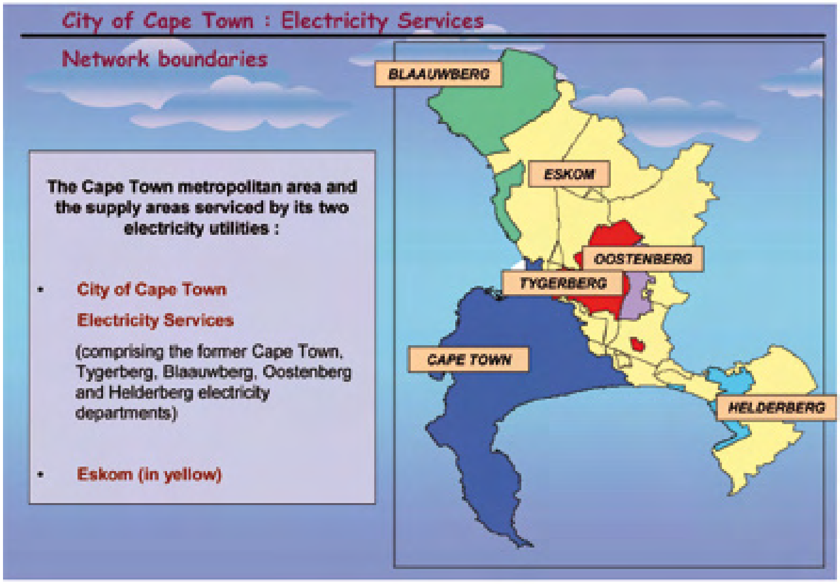


Figure 9-2: CCT electricity network boundaries

Eskom generation plants in the vicinity of Cape Town include Koeberg nuclear power station (1 800MW net capacity), emergency gas turbines at Acacia (171MW capacity), and the Palmiet pumped storage scheme for national grid load management (400MW capacity). Electricity from the national grid comes in the form of a 400kV line which can deliver a maximum of 2 600MW to the Western Cape. Two open cycle gas turbine plants, with a total capacity of approximately 1 050MW capacity are being built at a cost of R3.5bn, in Atlantis and Mossel Bay. These are liquid-fuel plants which are primarily designed for peaking capacity. Current schedule indicates that they will be completed before the winter of 2007.

Eskom is currently evaluating the potential of power generation from wind at the Klipheuwel wind farm, but no major wind farm developments are planned for in the short term.

The City of Cape Town (CCT) generates very little of its own energy – the vast majority is purchased from Eskom.

Steenbras Pumped Storage Plant

CCT owns a 160MW pumped storage plant at Steenbras, which pumps water to the Steenbras Dam in off-peak (cheap electricity) periods, and generates electricity from running the water down again in peak periods (i.e. hydro generation). Steenbras is used for load management rather than being a base-load generator. Depending on the amount of water flowing into upper Steenbras dam, the pumped storage plant can be either a net consumer or a net producer of electricity. Steenbras provided a net of 20GWh into the Cape Town grid over the last financial year[28]. Significant efficiency and transmission losses should, however, be considered for this plant.

Emergency Gas Turbines

Two gas turbines (40MW capacity each) situated at Roggebaai and Athlone respectively are currently requiring maintenance and are not in use. The CCT only plans to use these for emergency duty, as they have a very high running cost[29]. Eskom and the City of Cape Town have different tariff structures depending on the end user and its needs. Both supply electricity to the residential, commercial and industrial sectors. The majority of domestic users (72%) are on the prepaid system. The tariff structure is simply broken into Domestic 1 which suits electricity users who use more than 600kWh per month and Domestic 2 which suits users who consume less than 600kWh per month. Users who utilise 450kWh or less per month over a 12 month average will qualify for 50kWh per month of free basic electricity (FBE).

28 CCT Electricity Sent to System Spreadsheet, 2006
29 Wouter Roggen, CCT, Personal Communications, 17 May 2007

Electricity accounts for the majority of CO_2 emissions for the CCT (68%), largely due to the imports of coal-generated power. A further issue that is being faced by the poverty strike communities is that even though they have access to electricity it is too costly. The CCT has implemented a 'poverty tariff' of 50 kWh of free electricity given to houses using below 450 kWh per month but the issue of energy security still remains one looming over the poorer communities.

9.2.2 Coal

Coal for industrial, commercial and residential purposes is distributed largely by rail from mines to major distribution companies. From these depots it is then distributed by numerous smaller businesses, down to small street-level vendors who sell coal in small quantities to households. Transport costs are a major component of the final coal price in Cape Town, pushing the price up by 50 - 80% compared with Gauteng, and making coal largely too expensive for poor households in Cape Town. Table 9-3 shows the assumed extraction and distribution costs of different types of coals. Approximately 320 000 tonnes of coal are used within the City of Cape Town area per year (excluding Athlone).

Table 9-3: Assumed costs of extractions and distribution[30]

Type of coal mining	Cost ($/tonnes)
Export coal	20.1
Coke coal	38.1
Sasol coal	8.8
Electricity coal	8.8
Domestic coal	17.6

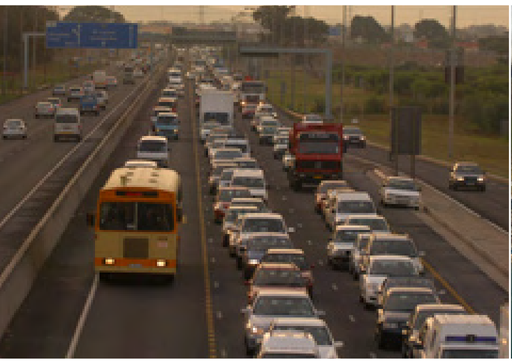
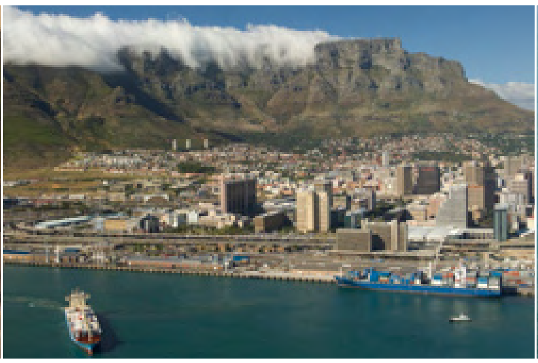
Considerable pollutants are produced annually from the operation of coal power stations. Table 9-4 shows approximate amounts of waste materials produced in one year from a coal power station of 1 000MW capacity.

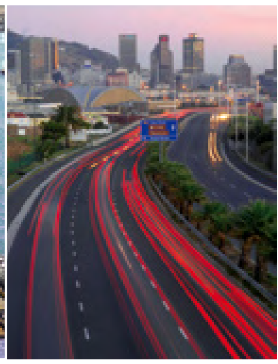
Table 9-4: Coal waste produced in one year from a 1000 MWe power station*

Quantity in tonnes	Type of Waste
8	Radio nuclides e.g. thorium (half-life:14 billion years)
42 000	SO_2
21 000	NO_x
5 000 000	CO_2
2 000	Particulates
2 640	Heavy metals: lead, arsenic, strontium, etc.

*Data Source: ERI, Preliminary Energy Outlook for South Africa, October 2001.

Coal waste is either blown into the air or scattered into large ash heaps, and it's combustion results in high gaseous emissions that severely impact local air quality, human health, and the greenhouse gas effect. Two of the primary issues with coal as a fuel source is that it is expensive to be used on a household level and the range of coal-derived pollutants, largely from its use in electricity generation, are significant contributors to serious local and global consequences, including global warming and poor local air quality.



[30] Energy policies for sustainable development in South Africa, ERI, 2006

9.2.3 Liquid fuels

Oil is South Africa's second largest primary energy source. The majority is imported, primarily in the form of crude oil. South Africa has five crude oil refineries, of which Calref, the Chevron-owned refinery, is located in Cape Town. Calref is a complex refinery with a distillation capacity of 100 000 barrels per day and has a current replacement cost of about $1-billion[31]. Calref provides Cape Town with the majority of its liquid fuel. It is unlikely that any more oil refineries will be built in South Africa. Currently if demand exceeds the refinery's capacity, extra refined fuel is imported from refineries in Singapore and Bahrain. The amount of refined fuel imported is expected to grow in the future as South Africa's demand for fuel exceeds its ability to refine[32]. Calref produces petrol, diesel, paraffin, jet fuel and LPG.

Table 9-5: Anticipated future shortfalls in liquid fuel refining capacity in SA

Millions of litres								
	2005 Refining capacity actual	2005 Demand actual	2005 Surplus/ (shortfall) actual	2012 Refining capacity	2012 Low growth demand	2012 Low growth Surplus/ (shortfall)	2012 High growth demand	2012 High growth Surplus/ (shortfall)
Petrol	13 300	12 106	1 194	13 000	13 440	(440)	15 400	(2 400)
Diesel	9 000	9 091	(091)	9 300	10 090	(790)	11 570	(2 270)
Kerosene*	3 700	3 044	656	3 800	3 380	420	3 870	(70)

*Kerosene includes jet fuel and illuminating paraffin

Source: SAPIA Annual Report 2005

9.2.4 Petrol and diesel

Petrol and diesel are marketed by oil companies. In Cape Town, refined petrol and diesel is bought from the refinery by the oil companies. Most petrol (97%) is sold by service stations in Cape Town while most diesel (64%) is sold in bulk. Road tankers transport petrol and diesel from the oil company's holding facility to service stations. Oil companies are increasingly outsourcing distribution functions as well as being engaged in affirmative procurement programmes. Government intervention prevents oil companies from owning service stations (prohibition of vertical integration). However, conditions linked to supply agreements require service station businesses to keep to relatively demanding signage and service standards, which maintains oil company control. Local authorities impose further stringent land zoning and safety requirements. It is thus financially demanding to establish such a station.

9.2.5 Paraffin

Paraffin is distributed from the refineries to oil company-owned bulk depots largely by road. Small transport companies take it from the depots to the numerous medium and small outlets in urban areas. In some areas, service stations also sell paraffin. The government regulates paraffin prices up to the retail level, specifying the maximum amount it can be sold for. It has also made paraffin VAT exempt to ease the burden on poor households. This is seen as an effective means of 'subsidising' such households, as a very high proportion of all paraffin sold is used by this income group. Paraffin supply chains reach into all urban areas. A study undertaken in 1997 indicates that supply chains are not excessively long, and that price mark-ups are usually not overly high[33].

9.2.6 Liquified petroleum gas (LPG)

Liquified petroleum gas (LPG) is transported from the refineries to large distributors and then to medium distributors. It is generally bottled at the refinery, although depots with mini-bulk tanks are becoming more common. LPG distribution is through most oil companies as well as Afrox. The distribution network of LPG is not nearly as well developed as that for paraffin, for various reasons. For one, it is not easy for small outlets to establish themselves. Prospective new retailers need to undergo training and their premises need to comply with various safety requirements. Further, the necessary space for safe LPG storage is often not available in dense low-income settlements. LPG bottles are also difficult to transport to and from distant outlets, which imposes a cost on dealers. There is also limited demand as the poor households cannot generally afford the necessary bottles and appliances. Currently the CCT has a limited supply, with the price escalating with an increase in demand. The DME is currently investigating regulation of the supply price of LPG.

9.2.7 Jet fuel

Jet fuel is not regulated and is sold in bulk to airports, the military, and commercially. In Cape Town, the largest consumer of jet fuel is Cape Town International Airport (CCIA). Jet fuel is sold from the refinery to Shell who have storage facilities at the airport. Shell then distributes the fuel to aeroplane companies as demand requires.

31 **State of Energy Report for Cape Town, 2003**
32 **SAPIA Annual Report, 2005**
33 **SEA, Shell Foundation: Market Analysis of the SME energy sector 2002**

9.2.8 Nuclear energy

South Africa's only nuclear facility, Koeberg is based in the Cape Town metro's boundaries. The facility has two reactors, with a combined net output of 1 800MW. Koeberg provided 11 293GWh of electricity in 2006 (Eskom 2006 Annual Report), lower than usual due to its several unscheduled shutdowns during the year. Koeberg has an economic life of a further 18 years (2025). As the Western Cape is not a coal producing area, Eskom's short to mid-term plan is amongst other options to expand nuclear capacity to cope with increasing demand. This will most likely be in the form of Pebble Bed Modular Reactors (PBMR) and a Pressurised Water Reactor (PWR).

9.2.8.1 Pebble Bed Modular Reactor (PBMR)

Each reactor will have a capacity of 165MW. A demonstration reactor near Koeberg is scheduled to start construction in 2009 and the first fuel is planned to be loaded four years later (2013). Construction of the fist commercial PBMR modules are planned to start three years after the first fuel has been loaded into the demonstration reactor (2016)[34]. Since 2004, the South African government has allocated significant funding to the project, while the Minister of Public Enterprises, Alec Erwin, stated an intent to eventually produce 4 000MW to 5 000MW of power from pebble bed reactors in South Africa. This equates to between 20 and 30 PBMR reactors of 165MW each. In June 2004, the South African Cabinet also approved a programme to train nuclear scientists.

9.2.8.2 Pressurised Water Reactor (PWR)

Eskom also has plans for another 4 000MW PWR (like Koeberg) in the Western Cape. They have currently listed several potential sites for its location[35]. Within Cape Town there is a level of discomfort on expanding the nuclear presence in the metropolitan area, and the City holds the position that residents need to have a say in this matter.

9.2.8.3 Koeberg's Nuclear Waste Disposal Plan[36]

Koeberg power station produces radioactive waste. Depending on its level of radioactivity, waste is divided into three groups – low-level waste, intermediate-level waste and spent fuel. Waste can be either solid, liquid or gaseous.

Low level waste

Low level waste contains low traces of radioactive contamination, and typically consists of day-to-day refuse such as paper, gloves, insulation material, plastics and disposable overalls. This waste is generated in the controlled radiological areas of the power station. These items are compressed into sealed, clearly marked steel drums and stored on site until they are moved by road to the designated waste disposal site at Vaalputs. On average 500 steel drums are shipped to Vaalputs every year. Vaalputs is the national nuclear waste disposal site for low and intermediate-level waste and is situated approximately 600 km north of Cape Town.

Intermediate level waste

This waste consists of purification sludge, radioactive resins, spent filter cartridges and irradiated scrap metal pieces from normal maintenance work. It is more radioactive than low-level waste but less radioactive than spent fuel. It is mixed in a very specific way with a sand/cement mixture, which is poured into sealed and appropriately marked concrete drums, which are also transported to the waste disposal site at Vaalputs. On average 100 concrete drums are produced annually. The nature of the concrete used is such that should a drum fall off a truck or break open the radioactive materials inside could not harm the public due to it being sealed inside the concrete.

Spent fuel

Spent fuel is fuel that has been used in the fission process. It contains high levels of radioactivity. One of the characteristics that distinguish spent fuel from less active waste is its thermal power. At Koeberg Nuclear Power Station, the spent fuel assemblies are stored under water in storage racks with sufficient capacity to contain these assemblies for the life of the station. Water cools the fuel rods and serves as an effective shield to protect workers in the fuel storage building from radiation. Radiation starts decreasing immediately after the fission reaction has stopped and within approximately 10 years has decreased by more than 95%. However, spent fuel contains a mix of radioactive isotopes, the most dangerous of which is plutonium, which has a half life of approximately 24 000 years. Spent fuel will either be sent to a reprocessing facility when uranium extraction becomes economically viable, or it will be disposed of at an approved repository. To date no approved repository has been established.

A pressurised water reactor type power station like Koeberg generates approximately 32 tonnes of spent fuel each year. Over a 40-year lifetime that adds up to 1 280 tonnes.

34 PBMR website, www.pbmr.com
35 Cape Times, 29 May 2007
36 ESKOM website, www.eskom.co.za

9.3 Complementary alternatives

In order to complement and reduce the vulnerability of the current supply of energy to the CCT, it would be prudent to consider renewable energy, as well as energy efficiency as measures to diversify and conserve the current supply of energy to the CCT.

9.3.1 Renewable energy

The CCT's renewable energy focus at present is on wind and solar water heaters. This is in keeping with commitments made at the Bonn 2004 Renewables Conference[37].

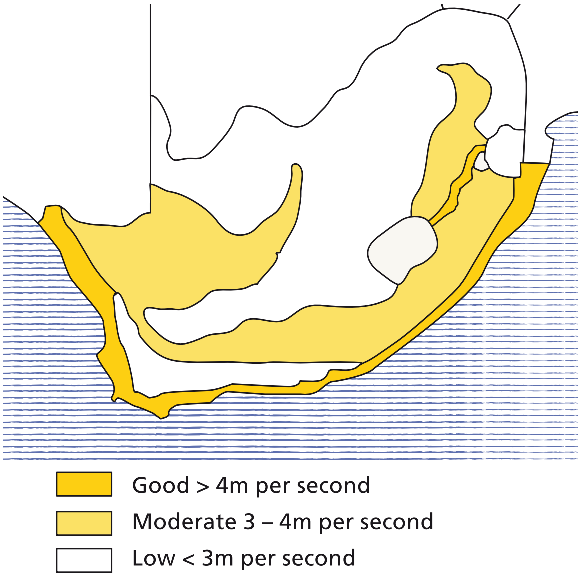


Figure 9-3: Wind generation capacity within South Africa

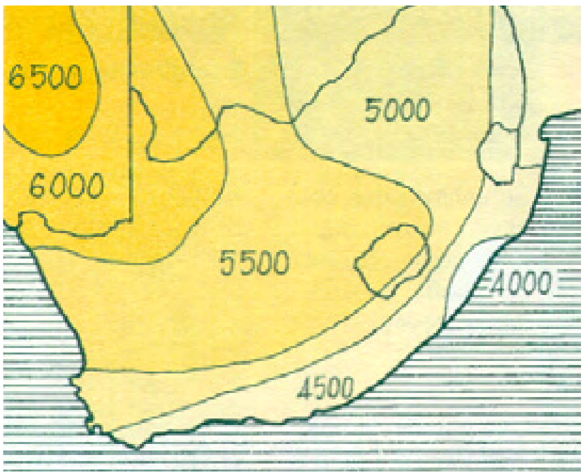


Figure 9-4: Annual Solar potential within South Africa, average radiation in watt hours per square metre per day

9.3.1.1 Wind

The wind potential within the CCT is excellent as shown in Figure 9-3 and in this vein the construction of the Darling Wind Generation Farm has been approved. At present four turbines will be constructed with a total output of 13MW. While these are still relatively expensive options, and are thus unlikely to proliferate in the short to medium term, they represent one option for environmentally conscious individuals or organisations to become less dependent on dirty coal-fired electricity generation.

9.3.1.2 Solar

South Africa experiences amongst the highest solar radiation levels in the world with daily solar radiation levels in the range of 5.5 to 8.5 kWh/m^2/day (Figure 9-4). Only a tiny part of the potential offered by this resource has been realised: the current total installed capacity in South Africa is just over 8MW – which is approximately equal to the amount of radiation falling on just 1km^2 (although conversion of direct solar energy to electricity or heat introduces losses which would need to be factored in for a more useful comparison).

As the solar map shows, the Northern Cape Province has a considerable sun resource base. While no overall resource potential estimate was obtained during the research of solar energy, the preliminary results of Eskom's Solar Thermal Electric Project suggest substantial potential for bulk electricity generation, and a promising solar future for South Africa in international terms.
Figure 9-4 shows that Cape Town has a solar resource potential of around 5 kWh/m^2/day. The solar values for Cape Town are lower than most other regions of South Africa partly due to the relatively cloudy winters associated with the Mediterranean climate. Cape Town is therefore not best placed for some solar applications. However, it is important to note that huge potential exists for passive solar design and solar water heating, which are financially and environmentally sound options for CCT.

The following technologies are suitable to use in Cape Town:
- Solar Water Heating (SWH) Systems; and
- Passive solar building design.

9.3.1.3 Energy efficiency

Improving the efficiency of energy use helps reduce energy consumption in the various sectors. It thus helps reduce gross energy consumption in the CCT. Thereby, reducing the future demand for energy, while allowing for more services and greater production to be supplied, without an increase in energy consumption. This requires the establishment of a good framework of regulation and investment in energy improvements, and the promotion of energy-efficient solutions and products that are accessible and attractive. Currently the Eskom DSM programme (www.eskomdsm.co.za) is a programme in support of the promotion of energy efficiency.

Based on information generated by the Long Range Energy Alternatives Planning (LEAP) modelling software the following interventions have been modelled, based on the targets set by the City of Cape Town's Energy and Climate Change Strategy[38].

37 Energy and Climate Change Strategy, CCT, 2006
38 Sustainable Energy Africa, 2007

Solar water heaters

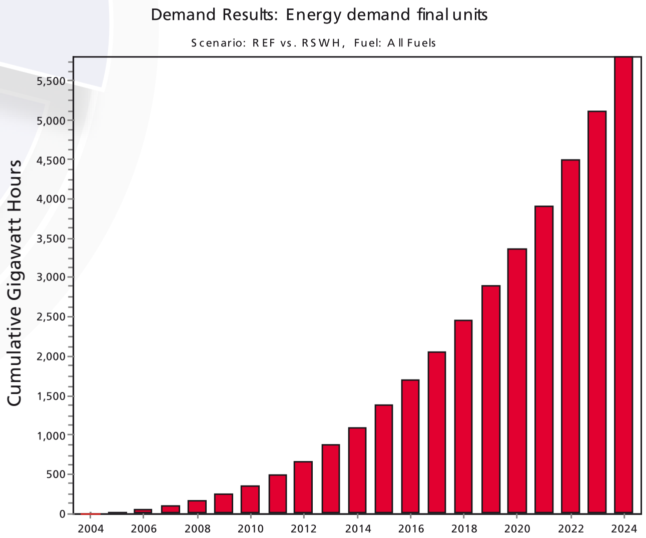


Figure 9-5: Installation of SWH in 10% of Cape Town's houses by 2010 and 50% by 2024

- Cumulative energy saving of 5 700GWh over 20yrs; and
- Final peak load reduction of 375MW (50% SWH installed).

Efficient lighting

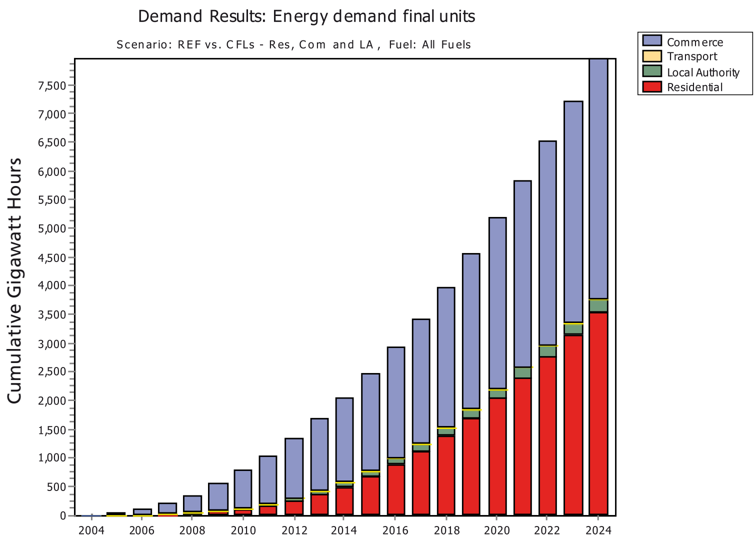


Figure 9-6: Efficient lighting: commercial and local authorities 100% saturation by 2010, residential 30% by 2010 and 90% by 2020

- Cumulative energy saving of 7 700GWh over 20 years; and
- Peak load reduction by 2024 of 290MW.

Insulated ceilings

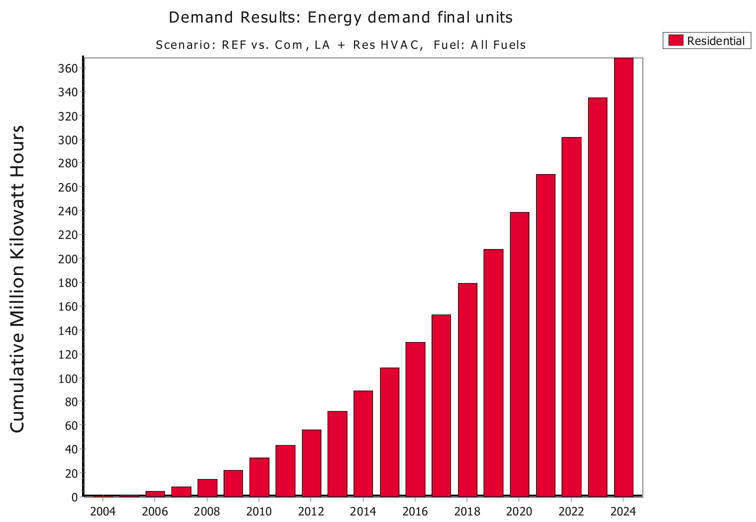


Figure 9-7: Ceilings on houses: retrofit existing houses by 2020

- Projected cumulative savings by 2024: 365 million kWh (Assuming a 20% reduction in energy used for space heating)

Efficient heating, ventilation and air conditioning (HVAC)

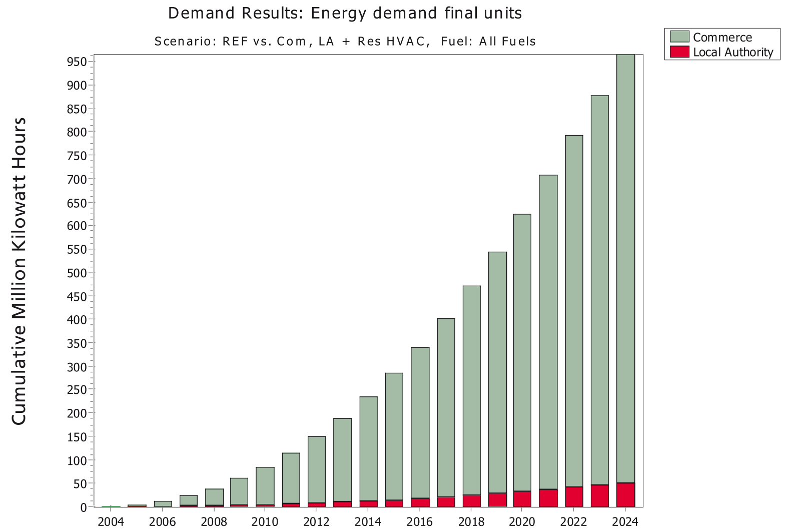


Figure 9-8: Efficient HVAC

- Achieved through changing behavioural patterns and installing more efficient systems; and
- Projected cumulative saving by 2024: 950 million kWh.

Transportation modal shift

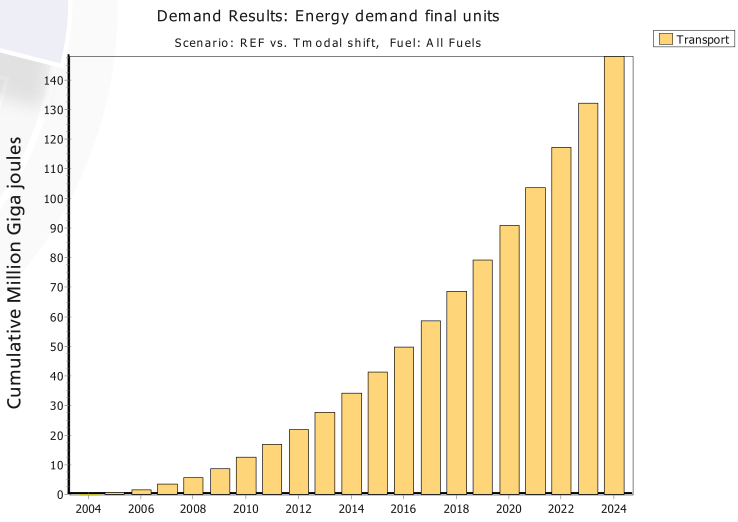


Figure 9-9: Transport modal shift

- Projected cumulative saving by 2024: 150 million GigaJoules (GJ)

Table 9-6: Potential savings from energy efficiency interventions

Solar Water Heaters	5 700GWh
Efficient Lighting	7 700GWh
Ceilings	365GWh
Efficient HVAC	950GWh
Transport	150 million GJ

Source: SEA: 2007

9.4 Summary

It is evident that the future supply of energy to the CCT would need to be complemented and diversified in order to meet future demand and ensure energy security. In line with this a range of options should be investigated. These options include:

- Energy efficiency (Council-owned buildings and operations, as well as promotion in the residential, commercial and industrial sectors); and
- Renewable energy (solar energy, wind power, energy from waste, etc.): promotion through regulation coupled with incentives.

At present, the CCT still experiences a number of barriers in the promotion of initiatives, as mentioned above. These include:

- The limitations linked to the interpretation of a city mandate on energy.
- A lack of stakeholder and institutional co-ordination on energy matters.
- Financial governance and the regulation of public private partnerships through the Municipal Finance Management Act (MFMA) and Municipal Systems Act (MSA).
- A lack of dedicated funding and co-ordination to support incentive schemes.
- Limitations on private generation capacity and a the absence of a feed-in tariff.

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Cape Town's natural environment is known for its beauty and biodiversity, providing essential resources and offering natural assests on which much of our economy depends.

Our rich history of people and their culture, religious, political and economic practices has given us a particular and precious heritage in Cape Town.

Cape Town has an impressive and constantly evolving urban environment. We need to create a more equitable and harmonious living environment.

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