BUFFALO CITY MUNICIPALITY

# STATE OF ENERGY REPORT

*Draft for Comment*

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**BUFFALO CITY MUNICIPALITY**
**STATE OF ENERGY REPORT**

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| | |
|---|---|
| AAU | Assigned Amount Units |
| ADM | Amathole District Municipality |
| BCM | Buffalo City Municipality |
| BRT | Bus Rapid Transport system |
| CDM | Clean Development Mechanism |
| CEF | Central Energy Fund |
| CER | Certified Emission Reductions |
| CO2e | Carbon Equivalent |
| DME | Department of Minerals and Energy |
| EIA | Environmental Impact Assessment |
| ECA | Environment Conservation Act (Act 73 of 1989) |
| EDI | |
| EE | Energy Efficiency |
| EEC | |
| EEDSM | Energy Efficiency and Demand Side Management |
| ELIDZ | East London Industrial Development Zone |
| ESCO | Energy Services Company |
| ERU | Emission Reduction Units |
| EU | European Union |
| GDP | Gross Domestic Product |
| GEF | Global Environmental Facility |
| GHG | Green House Gases |
| GWh | Gigawatt hour |
| HFO | Heavy Furnace Oil |
| KWh | Kilowatt hour |
| KWT | King Williams Town |
| IDP | Integrated Development Plan |
| IEMP | Integrated Environmental Management Planning Unit |
| IPP | Independent Power Producer |
| LED | Light Emitting Diode |
| LPG | Liquid Petroleum Gas |
| LPU | Large Power Users |
| LRP | Lead Replacement Petrol |
| MBSA | Mercedes Benz South Africa |
| MWh | Megawatt hour |
| NEMA | National Environmental Management Act (Act 107 of 1998) |
| NER | National Energy Regulator |
| PJ | Peta Joule |
| PPU | Prepaid Power Users |
| REDS | Regional Electricity Distributor |
| REEES | |
| RMU | Removal Units |
| SAPIA | South African Petroleum industries Association |
| SDF | Spatial Development Framework |
| SPU | Small Power Users |
| TLC | Transitional Local Council |
| TRECS | Tradable Renewable Energy Certificate System |
| TSA | Technical Service Area |
| UNFCCC | United Nations Framework Convention on Climate Change |
| ULP | Unleaded Petrol |
| UPS | Uninterrupted Power Source |
| WWTW | Waste Water Treatment Works |

## Acknowledgements


The following people are the members of the Project Steering Committee (PSC) which is responsible for driving the project.

| | |
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| Shirley Fergus | Buffalo City Municipality IEMP Unit |
| Brett Hagen | Buffalo City Municipality IEMP Unit |

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| Mike Mangold | BCM Agricultural Action Forum |

The following members of the BCM Council provided active participation. Foreword

# 1 BACKGROUND AND INTRODUCTION

## 1.1 Why a State of Energy Report?

Until recently, South Africa has enjoyed large amounts of cheap energy as a result of extensive national coal reserves and stable international oil prices. This situation has now changed. Due to the finite nature of fossil fuel, internationally we are quickly reaching the situation where demand for fossil fuel is outstripping the capacity to supply that fuel. National coal reserves are calculated to last between 100 and 200 years from now, but will become increasingly expensive to extract. Dwindling oil and coal reserves have serious implications for local and national energy security.

A further concern is that our heavy reliance on fossil fuels results in the release of unnaturally large amounts of Carbon Dioxide and other gasses into the atmosphere. These gasses accumulate in the atmosphere and trap radiation leaving the earth. This causes a greenhouse effect, which in turn leads to atmospheric warming. An overwhelming amount of scientific evidence shows that the earth's atmosphere has been, and is continuing, to heat up. Global warming has serious climatic and environmental consequences, likely to impact water supply, food security and the occurrence of natural disasters.

Cities are major consumers of energy, responsible for 40% on national consumption. As such, cities are key players in defining how energy will be generated and consumed in a sustainable way. In South Africa, most cities have taken a serious attitude towards energy sustainability, and have initiated studies to understand how energy is used, and developed strategies to work towards the further utilisation of energy in a sustainable way in future.

Buffalo City Municipality, in combination with national competencies and obligations, has a responsibility to ensure the continued, secure supply of energy in a sustainable way that does not harm our environment.

## 1.2 Project Objective

This report has been prepared at the request of the Buffalo City Municipality (BCM) and has been prepared by the appointed service providers ARCUS GIBB (Pty) Ltd. with the support from Sustainable Energy Africa and the Palmer Development Group

The project was identified through the BCM Environmental Management Plan as a means to develop an understanding of the energy supply and consumption patterns within BCM and to ultimately develop a policy and strategy to ensure the sustainable management of energy from renewable and non-renewable sources.

The aim of this report is to describe the state of energy within BCM, which includes an assessment of the data available relating to the energy supply and demand.

This is the first State of Energy Report compiled for Buffalo City Municipality and will likely be followed by a review in the years to come.

## 1.3 Structure of Report

This report first provides a background to BCM, giving a brief overview of its coverage as well as its overall demographic and economic profile and outlines the need for the study.

The second section provides a discussion on international, national and local imperatives that provides a thorough review of legislation and regulation pertinent to energy in South Africa and in Buffalo City, in order to give a full picture of the enabling environment.

The third section provides an overview of energy in South Africa in order to put the reader in context.

Section 4 then provides an energy balance as an overview of energy use by energy carrier, by users (demand sectors) and supply. It further provides an overview of the sources of data and the validity and quality of data collected for each component of the Report.

Section 5 provides detail on the energy supply aspect of the energy balance.

Sections 6 – 9 detail energy demand by the various sectors and provides a list of key issues pertaining to energy consumption patterns and highlights current initiatives and responses that are underway within each of the sectors.

Section 10 provides a description of renewable energy, energy efficiency and carbon trading and identifies potential Renewable Energy, Energy Efficiency and potential carbon trading opportunities within the BCM area.

Section 11 then concludes the State of Energy and provides conclusions and recommendations for future action by BCM in support of the preparation of a detailed Energy Strategy.

## 1.4 Introduction to BCM and a description of the study area

The Buffalo City Municipality (BCM) is located in the Amathole District of the Eastern Province. Buffalo City comprises the core urban centres along a corridor consisting of the port city of East London, Mdantsane, King Williams Town and Dimbaza. Dominant land uses include urban, peri-urban and rural settlement as well as commercial farmlands. Buffalo City's land area covers approximately 2 515$km^2$, with approximately 68 km of coastline Figure 1.

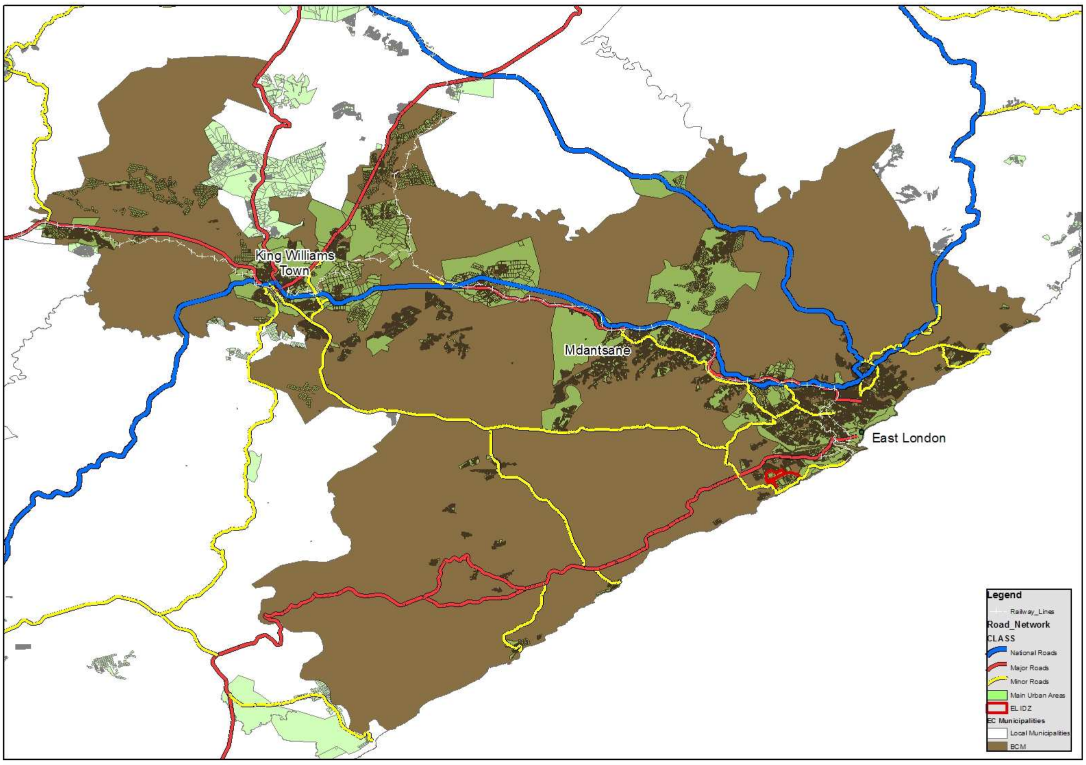



**Figure 1: Buffalo City Municipality illustrating major transport routes and key urban areas.**

Recent population estimates for BCM are in the order of 760 000. Population growth rates are in the order of 0.6% per annum. According to the household survey undertaken in 2007, 208 389 households were recorded. The average household is getting smaller, having decreased from 4 persons per household in 2001 to 3.7 people in 2007. With the migration of people into the urban centers from the rural areas, Buffalo City continues to experience a huge housing demand. In 2004, it was estimated that 75 000 households to not have access to adequate shelter.

Buffalo City remains to be one of the key economic hubs of the Eastern Cape Province and is the most important economy in the eastern part of the province. In 2004, it was estimated that BCM contributed 23% to the total GDP of the province and provided 19% of the Provinces formal employment opportunities.

# 2 INTERNATIONAL, NATIONAL AND LOCAL IMPERATIVES

## 2.1 International Imperatives for ensuring a sustainable approach to energy by cities

### 2.1.1 Finite Fossil Fuels

The world has a finite reserve of fossil fuels. Coal is expected to last 100 to 200 years, while oil is expected to last 50 years In 2008, oil has reached unprecedented prices. In inflation adjusted terms, the oil prices during the oil crisis in 1980 were between US$95 and US$100 per barrel. In 2008, that price has been far exceeded. In May 2008, oil had reached US$140 per barrel, the highest oil price in real terms since the early 20$^{th}$ century. It may be argued that this is symptomatic of the occurrence of peaking oil. Peaking oil is the point in time when, on a global scale, a maximum in oil output has been reached, as a result of maximum utilisation of global reserves. From this point in time, output will remain constant for a number of years, and thereafter will decline as reserves become exhausted. It has been predicted (for example by the World Energy Council, the US Department of Energy, and Shell Oil) that the point of peak oil will be reached between 2010 and 2030 (Hirsch 2005). However, oil *consumption* is increasing at an unprecedented rate as economies expand and populations grow. Once demand exceeds supply, and continues to grow, while supply dwindles, one can expect an exponential increase in oil prices.

Developing strategies to deal with finite fossil fuel supply is an important element in ensuring national and local energy security.

### 2.1.2 Climate Change

Climate Change is regarded by many as the world's most challenging environmental concern. Energy is closely linked to climate change as the burning of fossil fuels contributes to the rise in greenhouse gas concentrations, which is the driving force behind climate change. Much of our recent policy with regard to energy has been developed in response to global pressure as a result of South Africa's excessive contribution to climate change.

Carbon dioxide, the principal greenhouse gas, is released to the atmosphere by the burning of fossil fuels such as oil and coal (South Africa's main sources for power generation). This is exacerbated by deforestation and the conversion of natural vegetation to agriculture, which results in reduced uptake of carbon dioxide by plant matter. Factors behind the increased release of carbon dioxide to the atmosphere are industrialisation, inefficient use of energy, inefficient methods of production and excessive global consumption.

(a) United Nations Framework Convention on Climate Change

The Intergovernmental Negotiating Committee drafted the United Nations Framework Convention on Climate Change (UNFCCC), which was opened for signature in June 1992 at the Rio de Janeiro Earth Summit. The fundamental objective of the UNFCCC is to achieve stabilisation of the concentrations of greenhouse gases in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. South Africa ratified the UNFCCC in 1997, which enables South

Africa to apply for financial assistance for climate change related activities from the Global Environmental Facility (GEF).

(b) Kyoto Protocol

The Kyoto Protocol was introduced in 1997 at the third Conference of Parties. The conference resulted in a consensus decision to adopt the Protocol under which industrialised countries (Annex 1 countries) will reduce their combined greenhouse gas emissions by at least 5% compared to 1990 levels by the period 2008 to 2012.

The Protocol will come into force after it has been ratified by least 55 parties to the UNFCCC, including Annex 1 parties accounting for at least 55% of the total 1990 carbon dioxide emissions in this industrialised group.

South Africa acceded to the Kyoto Protocol in March 2002. Although the Kyoto Protocol does not commit the non-Annex 1 (developing) countries, like South Africa, to any quantified emission targets in the first commitment period (2008 to 2012), there is potential for low cost emission reduction options in these countries. The Clean Development Mechanism provides for trade in certified emission reductions between non- Annex 1 countries and Annex 1 countries and thus supports sustainable development with respect to greenhouse gas emissions in developing countries while helping Annex 1 countries to comply with their commitments under the Kyoto Protocol.

## 2.2 National Imperatives: Legislation and Policy

South Africa's energy policy has undergone significant changes with the transition to a constitutional democracy. Originally much national energy related legislation was focused around electricity tariffs and fuel sales and associated designation of responsibility. The White Paper on the Energy Policy for South Africa was regarded as the most important legislative development and was developed on the basis of global pressures from climate change, dwindling supplies of fossil fuels, environmental and health impacts and sustainable development. The recent electricity crisis in South Africa as well as rising oil costs, has sparked the release of the National Energy Bill and associated regulations.

### 2.2.1 Overarching National Legislation

(a) The Constitution of the Republic of South Africa (Act 108 of 1996)

The legal reference source for environmental law in South Africa is found in the Constitution of the Republic of South Africa, Act 108 of 1996. All environmental aspects should be interpreted within the context of the Constitution. The Constitution has enhanced the status of the environment by virtue of the fact that environmental rights have been established (Section 24) and because other rights created in the Bill of Rights may impact on environmental management. An objective of local government is to provide a safe and healthy environment (Section 152) and public administration must be accountable, transparent and encourage participation (Section 195(1)(e) to (g)).

(b) The National Environmental Management Act (Act 107 of 1998)

The National Environmental Management Act (Act 107 of 1998) commonly known as “NEMA” is South Africa’s overarching framework for environmental legislation. The object of NEMA is to provide for operative environmental governance by establishing principles for decision-making on matters affecting the environment, institutions that will promote co-operative governance, and procedures for co-ordinating environmental functions exercised by organs of state.

It sets out a number of principles that aim to implement the environmental policy of South Africa. These principles are designed, amongst other purposes, to serve as a general framework for environmental planning, as guidelines by reference to which organs of state must exercise their functions and to guide other law concerned with the protection or management of the environment.

The principles include a number of internationally recognized environmental law norms and some principles specific to South Africa, i.e. the:

- Preventive principle;
- Precautionary principle;
- Polluter pays principle; and
- Equitable access for the previously disadvantaged to ensure human well-being.

Chapter 5 of NEMA is designed to promote integrated environmental management. Environmental management must place people and their needs at the forefront of its concerns, and serve their physical, psychological, developmental, cultural and social interests equitably. Development must be socially, environmentally and economically sustainable. Sustainable development therefore requires the consideration of all relevant factors including the following:

- The disturbance of ecosystems and loss of biological diversity is avoided, or, minimised and remedied;
- The pollution and degradation of the environment are avoided, or, minimised and remedied;
- The disturbance of landscapes and sites that constitute the nation’s cultural heritage is avoided, or, minimised and remedied;
- That waste is avoided, or, minimised and re-used or recycled where possible and otherwise disposed of in a responsible manner;
- The <u>use and exploitation of non-renewable natural resources</u> should be utilised responsibly and equitably;
- The development, <u>use and exploitation of renewable resources</u> and the ecosystem of which they are part of do not exceed the level beyond which their integrity is jeopardised;
- A risk-averse and cautious approach is applied; and
- Negative impacts on the environment and on the people’s environmental rights be anticipated and prevented, and where they cannot be altogether prevented, are minimised and remedied.

(c) Environment Conservation Act (Act 73 of 1989)

The objectives of the Environment Conservation Act 73 of 1989 are to provide for the effective protection and controlled utilization of the environment. Following the enactment of NEMA, a number of the powers of the Act have either been repealed from or assigned to the provinces. These include the EIA Regulations for activities that were regarded as detrimental on the environment and were published under Government Notice Regulation 1182 of 05 September 1997, as amended. New EIA Regulations have been promulgated under Section 24(5) of NEMA and are published under Government Notices No. 385; 386 and 387.

Waste management is still coordinated and controlled under Section 20 of ECA. The National Waste Management Bill, currently in draft form, will replace this section of the Act.

### 2.2.2 Energy specific related policy

(a) White Paper on Energy Policy in South Africa (1998)

The 1998 white paper on energy policy provided the first energy related policy developed in the post-apartheid South Africa. The policy introduced the concept of integrated energy planning and created the shift from the traditional approach where policy focused on the supply side to demand side management as well. The Energy white paper covers a wide scope of policy problems and challenges. For example, emissions from coal based power stations have dire environmental implications, with potential long-term effects on the environment. The objectives set by the white paper focus on the forever increasing need for access to affordable energy services, improving energy governance, stimulating economic development, managing energy related environmental and health impacts.

(b) White Paper on the Promotion of Renewable Energy and Clean Energy Development

This white paper sets out Government's vision, policy principles, strategic goals and objectives for promoting and implementing renewable energy in South Africa.

In response to global concerns in terms of South Africa's contribution to the emission of greenhouse gases through of the use of coal for power generation purposes, the white paper presents Government's policy for promoting renewable forms of energy and its efficient use there of. The white paper is split into two parts:

- Part 1 – deals with the promotion of renewable energy. It explores various resources for renewable energy including wind, biomass, hydro, solar, wave energy, ocean currents and energy from waste.
- Part 2 - deals with the energy efficiency strategy of South Africa. It takes its mandate from the White Paper links energy sector development with national socio-economic development plans. It provides specific targets for reduction in energy demand by 2014 within given demand sectors, with an overall target of 12% reduction in consumption.

(c) National Energy Bill

The Minister of Minerals and Energy Affairs recently published in June 2008, the National Energy Bill which provides the legislative backing for the objectives of the Energy White Paper. The objectives of the Bill are to:

- Ensure uninterrupted supply of energy to the public;
- Promote diversity of supply of energy and its resources;

- Facilitate effective management of energy demand and its conservation;
- Promote energy research;
- Promote appropriate standards and specifications for the equipment, systems and processes used for producing, supplying and consuming energy;
- Ensure the collection of data and information relating to energy supply, transportation, and demand;
- Promote evidence-driven energy related sectors' policy formation;
- Provide for optimal supply, transformation, transportation, storage and demand of energy that is planned, organised and implemented in accordance with a balanced consideration of security of supply, economics, consumer protection and sustainable development;
- Provide for safety, health and environment matters that pertain to energy;
- Facilitate improvement of the quality of life of the people of the Republic;
- Commercialise energy related technologies;
- Ensure effective planning for energy supply, transportation and consumption;
- Promote sustainable development of South Africa's economy; and
- Ensure the fulfilment of international commitments and obligations pertaining to energy.

Furthermore the Bill specifies, "**the Minister may prescribe mandatory provision of any data and information reasonably required for the purposes of energy modelling and planning from any person.**" The production of this State of Energy Report is therefore directly in line with the reporting requirements of the Bill.

(d) Integrated Household Clean Energy Strategy

This strategy was prepared by the Department of Minerals and Energy to minimise the harmful health impacts of utilising coal as an energy source primarily in low-income households. The strategy is more applicable in the highveld, where coal represents the cheapest form of energy for low-income households. The strategy looks at options such as:

- Low smoke emission burning techniques;
- Low smoke emission fuels; and
- Housing insulation options.

(e) EDI Restructuring Bill (April 2003)

The Bill followed the Restructuring Blueprint issued by the Department of Minerals & Energy in 2001. The Blueprint sets out the objectives with the restructuring of the RSA EDI. It further addresses some of the pertinent issues with respect to RED formation and transfer of resources to REDs.

(f) NER Regulatory Policy on Energy Efficiency and Demand Side Management (EEDSM) for South African Electricity Industry (May 2004)

This policy sets annual EEDSM targets and specifies the programmes that would qualify for EEDSM funding. Eskom is obliged to ensure that these targets are met, and all metros in South Africa are obliged to incorporate EEDSM in their planning and to ensure EEDSM implementation. The policy describes the regulatory mechanisms to be implemented by the NER and outlines the following:

- Access to funding
- Administration of funds
- Assets ownership
- Development of EEDSM plans
- Establishment of the Energy Agency in the future
- Obligation of the future REDs to implement EEDSM to all end-users through ESCOs (Energy Services Companies)
- The requirement of licensees (distributors) to create awareness (advertise benefits) of EEDSM among customers and offer time-of-use tariffs to all industrial and commercial customers.

### 2.2.3 Electricity related policy

(a) Electricity Act

The electricity sector is governed by the Electricity Act (Act 41 of 1987, as amended). The Electricity Act describes the licensing of undertakings for the generation and supply of electricity, and the control over these functions. It deals with the setting and approval of electricity tariffs and conditions of supply. The Act states that the sale and supply of electricity within the area of jurisdiction of a local authority, shall (with some exceptions) be under the control of that authority. Here, the Act confirms the allocation of electricity reticulation as an exclusively local authority competence in the Constitution (Act 108 of 1996, Schedule 4, Part B).

The Act furthermore describes the functions and powers of the National Electricity Regulator. The NER is tasked to exercise control over the electricity supply industry so as to ensure order in the generation and efficient supply of electricity. Its tasks include tariff approvals and the setting of supply and service standards.

The Act, in Section 27, also establishes the illegality of theft of electricity.

(b) Electricity Regulation Act (Act No. 4 of 2006) Regulations

In 2008, the Minister of Minerals and Energy Affairs published draft regulations for comment on measures to minimise the need for electricity load shedding and associated blackouts. The regulations make provisions for energy efficient lighting in streets and highways, water heating in commercial and residential buildings, amongst others.

Of particular relevance to BCM, the following norms and standards are noteworthy:

- All street lights must be fitted with energy efficient bulbs;
- A municipality may pass by-laws prohibiting any other activity in the interest of energy efficiency or enforcing these regulations; and

- End user or customer with monthly consumption of 500kWh and above must be on time of use tariff not later than 2010.

### 2.2.4 Legislation on municipal governance

Buffalo City Municipality is an electricity supplying local authority and is therefore subject to various Acts relevant to local authorities in general.

(a) Municipal Systems Act

The Municipal Systems Act, Section 11(2) provides that a municipality exercises its authority by amongst others providing municipal services to the local community itself (11(2)(f)), or by appointing appropriate service providers in accordance with the criteria and process set out in Section 78. Section 78 requires a Local Authority to review its delivery of a service to determine whether it is more feasible to continue in-house delivery or to outsource the service in some manner. Section 77 prescribes seven situations or circumstances when the municipality is obliged to (i.e. ‘must’) consider the appropriate service delivery options. Section 76 provides that a municipality may provide a municipal service through an internal or external mechanism.

(b) Municipal Systems Act

The Municipal Structures Act, Section 83 refers to Municipalities’ rights as those determined in Sections 156 and 229 of the Constitution (i.e. that electricity and gas reticulation are municipal functions, and that surcharges may be levied on fees for services provided by or on behalf of the municipality and that such surcharges may be nationally regulated).

(c) Municipal Finance Management Act

The Municipal Finance Management Act, Section 13, regulates the disposal of capital assets, and Section 14 municipalities’ interests in companies and other entities. Chapter 9 of the Act deals with various matters related to municipal entities.

## 2.3 Local Policy and Imperatives

### 2.3.1 South African Cities Network

Buffalo City Municipality is a member of the South African Cities Network. The goals of the Cities Network are

The goals of the SA Cities Network include:

- Promotion of good governance and management of South African cities.
- Analysing strategic challenges facing South African cities, particularly in the context of global economic integration and national development.

The Cities Network promotes *Sustainable Cities* as a theme, which implies “social and economic development that responds appropriately to natural and other resources; and supports equity and efficiency in the use of resources”. This includes sustainable use of energy resources.

### 2.3.2 Local Agenda 21

Local Agenda 21 is an outcome of the United Nations Conference on Environment and Development. It provides a local framework for sustainable and equitable development. Local Agenda 21 is integrated into the Buffalo City Municipality Planning process.

### 2.3.3 Integrated Development Plan

The Integrated Development Plan (IDP) is the key strategic planning tool for BCM. The 2007/2008 IDP sets out a set of cluster issues, objectives and strategies. Among the IDP objectives under the Environmental Cluster, are objectives to:

- Utilize BCM's natural resources in a sustainable manner, including sustainable utilisation of energy (E6); and
- Respond to Climate Change, including emission avoidance projects (E10).

# 3 ENERGY IN SOUTH AFRICA

Energy in South Africa is dominated by electricity mainly generated through the burning of low-grade coal in large coal-fired plants as well as liquid fuels supply and transport.

The burning of coal and other fossil fuels has been recognized as a major factor influencing climate change through the emission of greenhouse gases, such as carbon dioxide. South Africa has double the world's average per-capita carbon emissions footprint: the global average is 4 tons $CO_2$ per year, while South Africa averages 8 tons of $CO_2$ per year. In so doing, South Africa is the 11$^{th}$ highest global contributor to global carbon emissions, and therefore it can expect to come under major pressure to reduce its utilisation of fossil fuels over the next few decades (Sustainable Energy Africa, 2007).

### 3.1.1 Energy Supply

In 2000, primary energy supply through coal accounted for 79% of supply, with crude oil 10% and renewable supply at 6% (See Figure 2). This primary energy supply to South Africa was estimated to have increased from 3 924PJ in 1993 to 4295PJ in 2000, an increase in 9.5%. Much of the primary energy source is processed to more conveniently usable forms, such as electricity and liquid/gas fuels.

Electricity generation accounts for 53% of South Africa's total coal usage or approximately 118 million tons per annum.

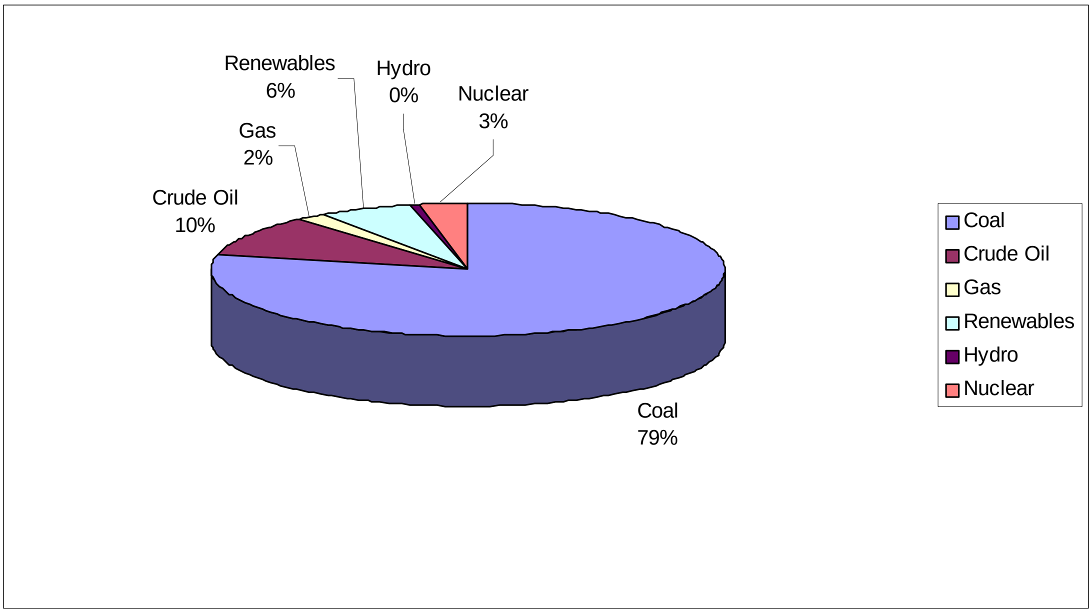



**Figure 2: Primary Energy Supply within South Africa (DME, 2005).**

### 3.1.2 Energy Consumption

In terms of demand on a national scale, industry (41%), transport 28% and residential (17%) account for the largest consumption on a sectoral basis (See Figure 3 below).

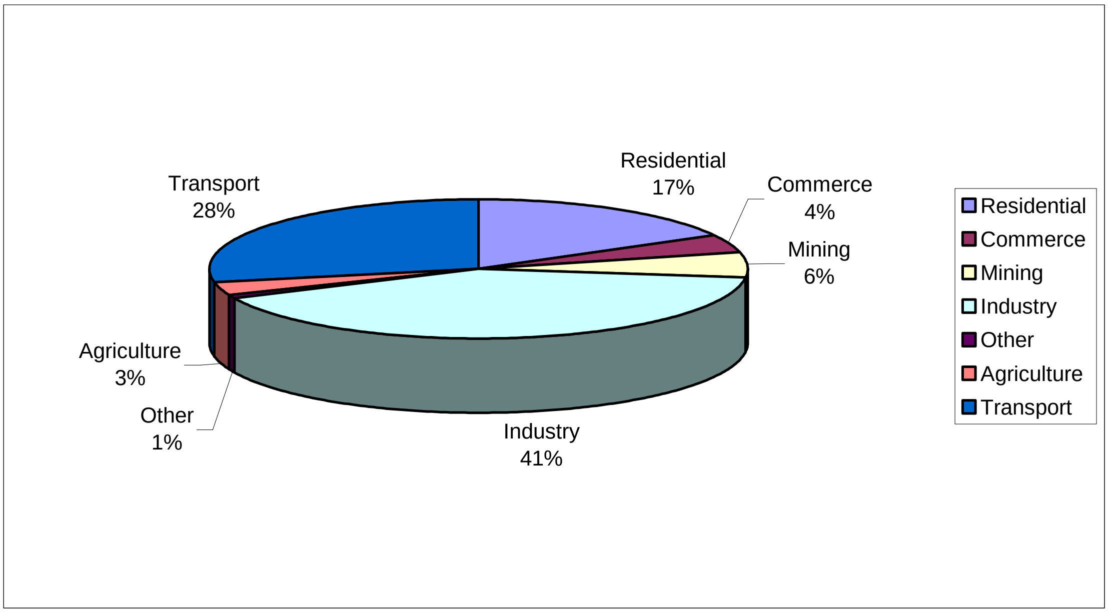



**Figure 3: Final Energy Use by Sector (DME, 2005).**

Industry and the Transport Sector rely heavily on liquid fuels as energy supply with crude oil accounting for South Africa's largest import. Increasing demand from rising economies globally (e.g. China) has caused exponential increases in crude oil prices (See Figure 4) which is in turn effecting South Africa's economy and is forcing industry to consider alternative means of energy supply.

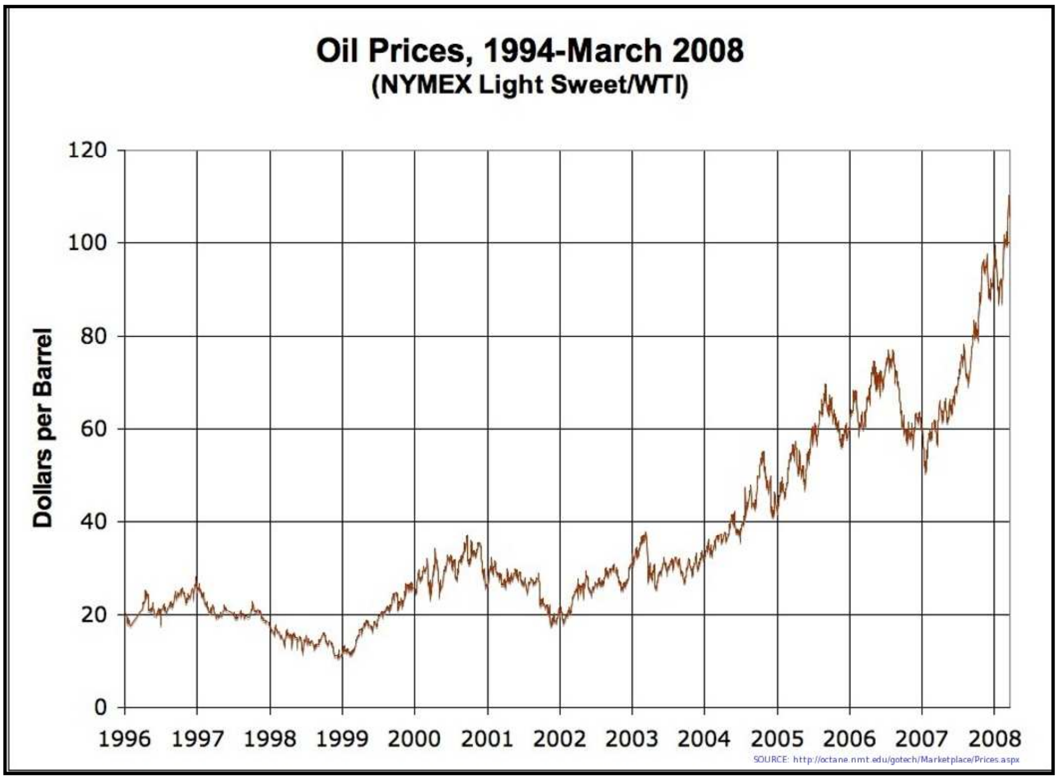



**Figure 4: Global Crude Oil Prices ([www.wikipaedia.com](www.wikipaedia.com)).**

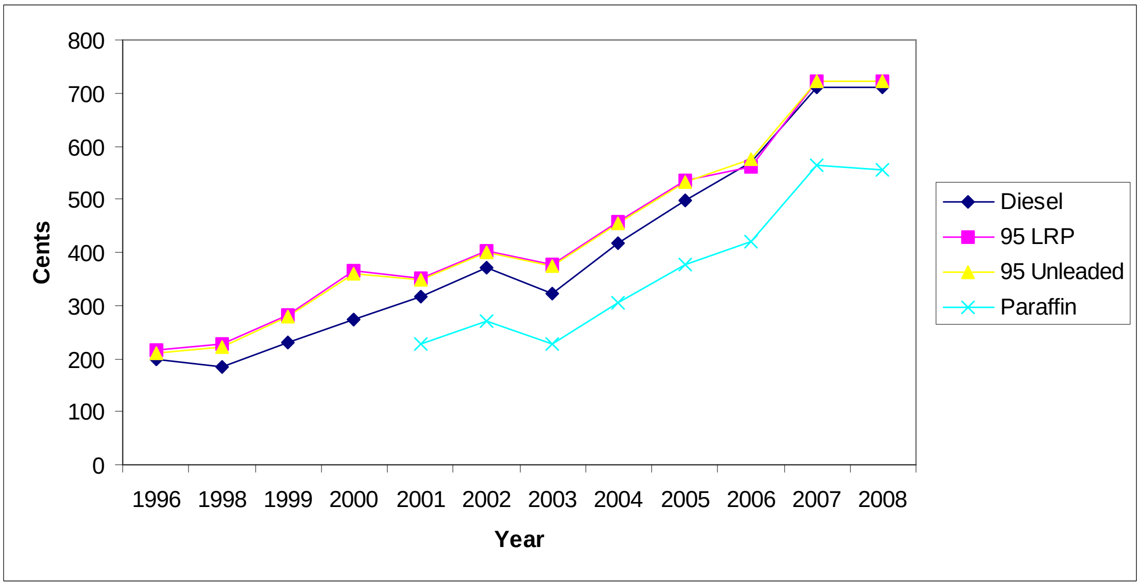



**Figure 5: South African fuel prices as supplied by SAPIA.**

In terms of national government's imperative to provide all households with access to electricity by 2013, a major investment into electrical infrastructure has occurred to achieve a current electricity access rate in the order of 70% and approximately 300 000 new connections per year. However, many South Africans, especially those in the poorer income groups and those below the poverty line, still make use of more traditional fuels for heating, cooking and lighting. In 2001, 2.5 million households used candles for lighting and 737 300 households used paraffin and, on average, 23 % of households used wood fuel for cooking and heating while 18% used paraffin for these same purposes. Of these households, 7% used coal for heating. This highlights the significant number of people that still rely on wood, coal and paraffin for their energy needs.

In addition to the household electrification targets described above, South Africa has experienced, and is experiencing major economic growth (4.9% in 2005, with some current estimates of 6%) which has increased energy consumption dramatically over the last decade. The demand for electricity is effectively outstripping the ability the South African Utility, ESKOM, to supply electricity, both in terms of generation and transmission. This has stimulated ESKOM to place major emphasis on demand side electricity management, where electricity users are encouraged to improve their energy efficiency and to install facilities that utilise alternative sources of energy.

South Africa's recent bout of load shedding[1] is an example of the extremities of the current national electricity crisis where peak demand for electricity can only be met by temporarily cutting off the supply to various consumers in the country and effectively spreading and sharing the available load. Between the period from 2006 to 2007, 4.31% more energy was consumed and the growth in peak demand was in the order of 4.90%.

[1] What is Load Shedding?

When there is not enough electricity available to meet the demand from all Eskom's customers, it could be necessary to interrupt supply to certain areas. This is called load shedding.

South Africa's electricity prices are comparatively very low when compared to other countries around the world. Electricity prices are projected to increase significantly in the near future in order to fund the new capacity being built which projected increases in the order of 50%.

Other national initiatives underway to lessen the demand on electricity as set out by national government include retrofitting light bulbs with energy efficient ones, installation of and provision of solar water geyser subsidies as well as substantial investment into renewable sources of energy.

## 3.2 Key Role Players in South Africa's energy picture

### 3.2.1 The Department of Minerals and Energy

The Department of Minerals and Energy is the national department responsible for management of mineral and energy related affairs. In terms of energy, the role of the DME is to develop, implement and enforce energy related policy, legislation and regulation.

### 3.2.2 The National Energy Regulator

The National Energy Regulator (NER) is tasked to exercise control over the electricity supply industry so as to ensure order in the generation and efficient supply of electricity. Its tasks include tariff approvals and the setting of supply and service standards

### 3.2.3 The Central Energy Fund

The Central Energy Fund's main focus is aimed at contributing to the development of South Africa's energy sector by facilitating the universal access to energy, including the increased use of renewable energy. The CEF renders operational support to the energy sector in the form of treasury services, including the raising of funds both locally and internationally

### 3.2.4 ESKOM

Eskom Holdings generates, transports and distributes approximately 95% of South Africa's electricity – making up 60% of the total electricity consumed on the African continent.

Eskom sells power directly to some 6 000 industrial, 18 000 commercial, 70 000 agricultural and 3 million residential customers. It owns and operates a number of coal-fired, gas-fired, hydro and pumped storage power stations, as well as one nuclear power station.

# 4 ENERGY BALANCE AND DATA ACQUISTION

## 4.1 Energy Balance in Physical Terms

An energy balance is a means of understanding how energy is used in terms of supply and demand. In this report, energy supply is generally considered in terms of energy types (such as electricity and liquid fuels), while demand is considered in terms of sectors (such as domestic and transport).

A matrix of energy demand by sector, against energy type, is shown in Table 1.

**Table 1: Energy demand matrix for BCM, showing demand by sector in terms of energy type. Energy types are expressed in physical units.**

| Energy Source | Household | Agriculture | *Mining* | *Industrial* | *Commercial - including service industries.* | Industry and commerce TOTAL | Gov Institutions (schools, hospitals, prisons, bisho) | Local Authority | Transport | Total | *Unit* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Electricity municipal coal/nuclear/gas source | 387,891,651 | | | 650,457,503 | 86,118,491 | 736,575,993 | | 41,604,168 | | **1,166,071,812** | *kwh* |
| Electricity municipal renewable source | | | | | | | | | | **0** | *kwh* |
| Electricity eskom coal/nuclear/gas source | 50,968,235 | 6,857,228 | 1,184,901 | | | 59,937,491 | | 2,670,387 | 3,945,688 | **125,563,930** | *kwh* |
| Electricity eskom renewable source | | | | | | | | | | **0** | *kwh* |
| **Electricity city total** | **438,859,886** | **6,857,228** | **1,184,901** | **650,457,503** | **86,118,491** | **796,513,484** | **0** | **44,274,555** | **3,945,688** | **1,291,635,742** | **kwh** |
| Petrol | | 97,847 | | | | 0 | 9,733 | 813,990 | 201,321,415 | **202,242,985** | *litre* |
| Diesel | | 9,430,238 | 17,149 | | | 1,206,717 | 17,051 | 1,001,515 | 133,380,045 | **145,052,715** | *litre* |
| Paraffin | 17,226,480 | 3,609,506 | 2,000 | | | 23,433,674 | | | 623,937 | **44,895,597** | *Litre* |
| LPG | 534,152 | | | | | 534,152 | | | | **1,068,303** | *m3* |
| Jet fuel | | | | | | | | | 16,328,376 | **16,328,376** | *litre* |
| HFO | | | | | | 9,092,014 | | | | **9092014** | *litres* |
| Biodiesel | | | | | | | | | | **0** | *litre* |
| Fuelwood | 10,422,274 | | | | | | | | | **10,422,274** | *kg* |
| Coal | 475,800 | | | 60,400,000 | 540,000 | 68340000 | 600,000 | | | **69,415,800** | *kg* |
| Natural Gas | | | | | | | | | | **0** | *kg* |
| Other energy sources (e.g. off-grid renewable) | | | | | | | | | | **0** | |

## 4.2 BCM Energy Demand Matrix expressed in Gigajoules

Table 1 shows energy usage in physical quantities such as kilowatt-hours, litres and kilograms. However, it is not easy to compare the energy contained within a kilowatt hour of electricity with the energy contained within a litre of petrol, for example. In order for the use of energy by different sectors to be compared, it is useful to express the energy values in a common unit. This unit is a Gigajoule, which is 1,000,000,000 joules[2]. The energy matrix in Table 1 is expressed in Gigajoule format in Table 3. The different forms of energy have been converted to Gigajoules by means of conversion factors. The conversion factors are given in Table 2.

**Table 2: Factors for conversion of energy types to values in Gigajoules.**

| Energy source | X | Units | = | Y | GJ |
|---|---|---|---|---|---|
| Electricity | 1 | KWh | = | 0.0036 | GJ |
| Coal (Bituminous) | 1 | Kg | = | 0.031 | GJ |
| Anthracite | 1 | Kg | = | 0.029 | GJ |
| Coke | 1 | Kg | = | 0.034 | GJ |
| Heavy Furnace oil | 1 | Litres | = | 0.040 | GJ |
| Diesel | 1 | Litres | = | 0.037 | GJ |
| Paraffin | 1 | Litres | = | 0.036 | GJ |
| Wood | 1 | Kg | = | 0.019 | GJ |
| Gas (Natural) | 1 | $m^3$ | = | 0.039 | GJ |
| LPG | 1 | $m^3$ | = | 0.025 | GJ |
| Petrol | 1 | Litres | = | 0.034 | GJ |

*Source: Energy Information Administration, USA*

In 2007, BCM consumed 22,619,289 Gj of energy. To put this in understandable terms it is the same amount of energy needed to lift 2,228,312,733,043,260kg (2,228 trillion tons) of mass 1 metre above the earth's surface.
That means that, per person, the same amount of energy is used as that required to lift 2,971,083 tons of mass 1 metre above the ground.

[2] One joule is the equivalent of one watt-second. It is the amount of work done when one Newton weight is lifted over a distance of one metre. This is the same as lifting a small apple straight up by a height of one metre.

**Table 3: Energy demand matrix for BCM expressed in Gigajoules.**

| Energy Source | Household | Agriculture | *Mining* | *Industrial* | *Commercial - including service industries.* | Industry and commerce TOTAL | Gov Institutions (schools, hospitals, prisons, bisho) | Local Authority | Transport | Total | *Unit* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Electricity municipal coal/nuclear/gas source | 1,396,410 | | | 2,341,647 | 310,027 | 2,651,674 | | 149,775 | | **4,197,859** | *GJ* |
| Electricity municipal renewable source | | | | | | | | | | **0** | *GJ* |
| Electricity eskom coal/nuclear/gas source | 183,486 | 24,686 | 4,266 | | | 215,775 | | 9,613 | 14,204 | **452,030** | *GJ* |
| Electricity eskom renewable source | | | | | | | | | | **0** | *GJ* |
| **Total Electricity** | **1,579,896** | **24,686** | **4,266** | **2,341,647** | **310,027** | **2,867,449** | | **159,388** | **14,204** | **4,649,889** | **GJ** |
| Petrol | | 3,327 | | | | | 331 | 27,676 | 6,844,928 | **6,876,261** | *GJ* |
| Diesel | | 348,919 | 635 | | | 44,649 | 631 | 37,056 | 4,935,062 | **5,366,950** | *GJ* |
| Paraffin | 620,153 | 129,942 | 72 | | | 843,612 | | | 22,462 | **1,616,241** | *GJ* |
| LPG | 13,354 | | | | | 13,354 | | | | **26,708** | *GJ* |
| Jet Fuel | | | | | | | | | 587,822 | **587,822** | *GJ* |
| HFO | | | | | | 363,681 | | | | **363,681** | *GJ* |
| Biodiesel | | | | | | | | | | **0** | *GJ* |
| Fuelwood | 198,023 | | | | | | | | | **198,023** | *GJ* |
| Coal | 14,750 | | | 1,872,400 | 16,740 | 2,118,540 | 18,600 | | | **2,151,890** | *GJ* |
| Natural Gas | 0 | | | | | | | | | **0** | *GJ* |
| **TOTAL** | **2,426,176** | **506,874** | **4,972** | **4,214,047** | **326,767** | **6,251,284** | **19,562** | **224,120** | **12,404,478** | **21,837,465** | |

## 4.3 Carbon Emissions Matrix

For every unit of fossil fuel we use, whether through burning coal for the generation of electricity in a power station, or the burning of petrol in the engine of a car, $CO_2$ is released into the atmosphere. In BCM, 401,283,311 litres of liquid fuel, 69,415,800 kg of coal and 1,291,635,742 kwh of electricity was consumed in 2007.
Calculation of $CO_2$ emitted by the consumption of this energy is based on emissions factors for different energy types. The emission factors used in the report are shown in Table 4 below.

**Table 4: $CO_2$ emissions factors for energy types used in BCM.**

| Energy Source | Tons emitted per GJ |
|---|---|
| Electricity | 0.3056 |
| Paraffin | 0.0717 |
| LPG | 0.063 |
| Coal | 0.0944 |
| Petrol | 0.0692 |
| Diesel | 0.0739 |
| HFO | 0.0772 |
| Wood | 0 (assuming sustainable harvest) |

*Source: IPCC Guidelines for National Greenhouse Gas Inventories, 1996*

The emissions for the sectors within BCM are shown in Table 5 below. A total of 2,679,275 tons of $CO_2$ was emitted into the atmosphere as a result of energy consumption in BCM in 2007.

**Table 5: Carbon emissions per sector in terms of energy type. Carbon emissions expressed in tons of $CO_2$ emitted.**

| Energy Source | Household | Agriculture | Mining | Industrial | Commercial - including service industries. | Industry and commerce TOTAL | Gov Institutions (schools, hospitals, prisons, bisho) | Local Authority | Transport | Total | Unit |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Electricity municipal coal/nuclear/gas source | 426,743 | | | 715,607 | 94,744 | 810,351 | | 45,771 | | **1,282,866** | $tCO^2$ |
| Electricity municipal renewable source | | | | | | | | | | **0** | $tCO^2$ |
| Electricity eskom coal/nuclear/gas source | 56,073 | 7,544 | 1,304 | | | 65,941 | | 2,938 | 4,341 | **138,140** | $tCO^2$ |
| Electricity eskom renewable source | | | | | | | | | | **0** | $tCO^2$ |
| **Total Electricity** | **482,816** | **7,544** | **1,304** | **715,607** | **94,744** | **876,292** | | **48,709** | **4,341** | **1,421,006** | $tCO^2$ |
| Petrol | | 230 | | | | | 23 | 1,915 | 473,669 | **475,837** | $tCO^2$ |
| Diesel | | 25,785 | 47 | | | 3,300 | 47 | 2,738 | 364,701 | **396,618** | $tCO^2$ |
| Paraffin | 44,465 | 9,317 | 5 | | | 60,487 | | | 1,611 | **115,885** | $tCO^2$ |
| LPG | 841 | | | | | 841 | | | | **1,683** | $tCO^2$ |
| Jet Fuel | | | | | | 0 | | | 37,033 | **37,033** | $tCO^2$ |
| HFO | | | | | | 28,076 | | | | **28,076** | $tCO^2$ |
| Biodiesel | | | | | | | | | | **0** | $tCO^2$ |
| Fuelwood | | | | | | | | | | **0** | $tCO^2$ |
| Coal | 1,392 | | | 176,755 | 1,580 | 199,990 | 1,756 | | | **203,138** | $tCO^2$ |
| **TOTAL** | **529,515** | **42,876** | **1,356** | **892,362** | **96,324** | **1,168,986** | **1,825** | **53,363** | **881,354** | **2,679,275** | $tCO^2$ |

## 4.4 Data Sources

### 4.4.1 Electricity Supply and Demand

(a) Municipal Supply and Demand

Supply of electricity to the municipality was obtained from Eskom sales records. Supplied sales records were broken down into monthly units over a period of five years from 2003 to 2008. In 2007, 1,383,245,181 kwh was sold to BCM.

Monthly electricity demand from the municipal grid was obtained from municipal tariff and metering records, and from discussions with BCM Electricity. Records were supplied in a monthly format extending from June 2007 to April 2008. Based on these records, total demand for 2007 was extrapolated to 1,166,071,812 kwh.

The above municipal figure represents a shortfall of 217,173,369 kwh when compared to Eskom Supply. This shortfall is corroborated by the fact that monthly municipal billing records showed roughly 18 to 12 million fewer kwh sold/supplied than purchased from Eskom for the corresponding month in Eskom Records. This difference may be attributable to illegal connections (the BCM 2007 Quality of Life survey shows, for example, that 6.2 percent of connections in urban informal areas are illegal). However, the difference may also be linked to differences in methods of recording data, or simply to the fact that a major user, such as the IDZ, has been excluded from the billing records supplied.

(b) Eskom Supply

BCM Electricity supplies mostly to urban users while Eskom supplies mostly to rural users. However, Eskom supply data is based on Technical Service Areas (TSAs). East London and King Williamstown TSAs cover the boundaries of BCM. However, the TSAs extend far beyond the physical borders of BCM (KWT TSA extends as far as Stutterheim). Eskom systems are unable to directly calculate the number of customers and electricity consumption exactly within the physical boundaries of BCM. Often their reticulation network straddles the boundary of BCM. Eskom supply to BCM was therefore derived using the following methods.

**Large Power Users**
A full list of large power users within the East London and KWT technical service areas was generated. Each power user was then cross referenced to a customer address from a different Eskom Database. Thereafter, each customer, based on their address, or based on knowledge of the location of their enterprise, was either retained or eliminated from the list. This yielded a final list of LPUs and associated consumption data within BCM boundaries.

**Small Power Users and Prepaid Power Users**
A dataset of Small Power Users (SPUs) and Prepaid Power Users, which could be expressed in GIS format was supplied by Eskom. The data points were overlaid with the BCM boundary shapefile. All SPUs and PPUs falling within the boundaries of the BCM shapefile were extracted. This yielded the number of SPUs and PPUs falling within BCM. The average monthly non agricultural consumption per PPU and SPU within the East London and KWT TSA was calculated. The averages were then multiplied by the number of PPUs and SPUs respectively within BCM to give a total PPU and SPU consumption within the borders of the municipality.

### 4.4.2 Liquid Fuels

(a) Supply

Data on quantities of liquid fuels have been supplied by the South African Petroleum Industries Association (SAPIA). SAPIA figures are disaggregated into the following categories:

- Agricultural Co-ops;
- Construction;
- Farmers;
- General Dealers;
- Independent LPG marketers;
- Government;
- Local Authorities;
- Mining;
- Remainder of General Trade;
- Retail – garages;
- Road Haulage; and
- Transnet.

“Agricultural Co-ops” and “Farmers” were grouped under the *Agricultural Sector* in the Energy Balance.
“Remainder of General Trade”, “Retail – garages”, “Road Haulage”, and “Transnet” were grouped under *Transport* in the Energy Balance.
“Construction” was incorporated into *Industry and Commerce: Total* in the Energy Balance. However, it is likely that certain amounts from “Remainder of General Trade” may have been utilised for industrial purposes.

The East London airport confirms that 1.3 million litres of jetfuel and 25000 litres of avgas is supplied at the East London Airport per month. This correlates closely with SAPIA figures.

Petroleum, Diesel, Jetfuel and HFO information supplied by SAPIA can be considered to be an adequate approximation of supplies to BCM, in that these fuel types are strongly correlated with demand in Urban Areas. BCM incorporates the urban areas of the former TRCs. However, paraffin and LPG consumption is less strongly correlated with urban areas. One can therefore expect overstated SAPIA figures for BCM. This is born out by the fact that paraffin supply to General Stores exceeds estimated demand by double.

(b) Demand

Data on Petroleum, Diesel, Jetfuel, LPG and HFO demand had not been obtained at the time of writing.

Household paraffin demand has been calculated as follows:

- Individual household consumption was researched through reference to national studies, including Madubansi and Shackleton (2006) and Panday and Mafu (2007).
- Studies show that paraffin consumption in unelectrified houses varies from 10 to 30 litres per month.
- Once electrified, poor electrified households reduce consumption to between 5 and 10 litres per month.

- Reference to the Duncan Village Shack Survey, and discussions with BCM Disaster Management Researchers, indicated that informal households in BCM are likely to use on average 22.5 litres per month for cooking purposes.
- Bearing in mind that paraffin-using households in BCM includes a certain portion of electrified households (BCM Quality of Life Survey, 2007), but that paraffin is also used for heating purposes, a final estimate of average paraffin consumption per household of 20 litres per month was arrived at.
- This average was multiplied by the number of households using paraffin for cooking in 2007 (2007 community survey), to give an annual total domestic consumption estimate of 17,226,480 litres.
- The above figure is far below the SAPIA total volume supplied to General Dealers selling paraffin. This is probably attributable to the fact that the SAPIA area of supply includes large tracks of rural villages not included in BCM.

#### 4.4.3 Fuelwood

(a) Supply

No data on supply of fuelwood was obtainable at the time of writing. It is likely that the fuelwood is supplied in a variety of forms, including local informal collection, informal sale of fire wood, and sale of firewood through outlets such as trading stores.

(b) Demand

Household fuelwood demand in BCM has been calculated as follows:

- Individual household fuelwood consumption figures were researched with reference to national studies. Particular reference was made to Shackleton *et al* (2007), who give results of fuelwood use surveys in the Grahamstown area of the Eastern Cape.
- An annual fuelwood consumption figure was derived from Shackleton *et al* (2007). This figure was multiplied by the number of fuelwood users in BCM as per the 2007 Stats SA community survey.

It is recognised that fuelwood or charcoal is also used by Pizza restaurants in BCM, but data is currently not available in consumption in this regard.

#### 4.4.4 Coal

(a) Supply:

Coal is predominantly supplied by one coal wholesaler in BCM, namely Macphail. The coal merchant is unwilling to supply current data on sales within BCM. However, data had been supplied to BCM in 2004. This data has been incorporated into the current energy balance.

(b) Demand

Data based on which demand figures could be generated was not available at the time of writing.

## 4.5 Data issues

### 4.5.1 Municipal Electricity

- Discrepancy between Eskom Supply to BCM, and BCM metering and billing records.
- Commercial users (e.g. office blocks) and Government institutions such as hospitals and prisons are recorded as large power users together with small industries such as restaurants and butcheries etc. This prevents disaggregation into “commercial, including service industries”, and “government institutions”.

### 4.5.2 Eskom Electricity

- Eskom areas of supply, namely Technical Service Areas (TSAs) do not match BCM area of demand (in other words TSA boundaries do not overlap with BCM boundaries, which means that precise figures cannot be supplied for BCM).
- Eskom Small Power Users do not only include domestic households, but also general stores, small-holdings, and other facilities. This may inflate the per-user domestic consumption figure.
- Eskom supply to Large Power Users is not disaggregated into industrial commercial or government institution. In the energy balance, the LPU total has been reflected under “Industry and Commerce” total.

### 4.5.3 Liquid Fuels:

SAPIA data is supplied on the basis of former magisterial districts. The two former magisterial districts that fall into Buffalo City Municipality include the East London TLC and the King Williams Town TLC. There is a slight overlap where the former East London TLC includes portions of the Great Kei Municipality, and the former King Williams Town TLC includes portions of Ngqushwa Municipality. The overlap is illustrated in Figure 6.

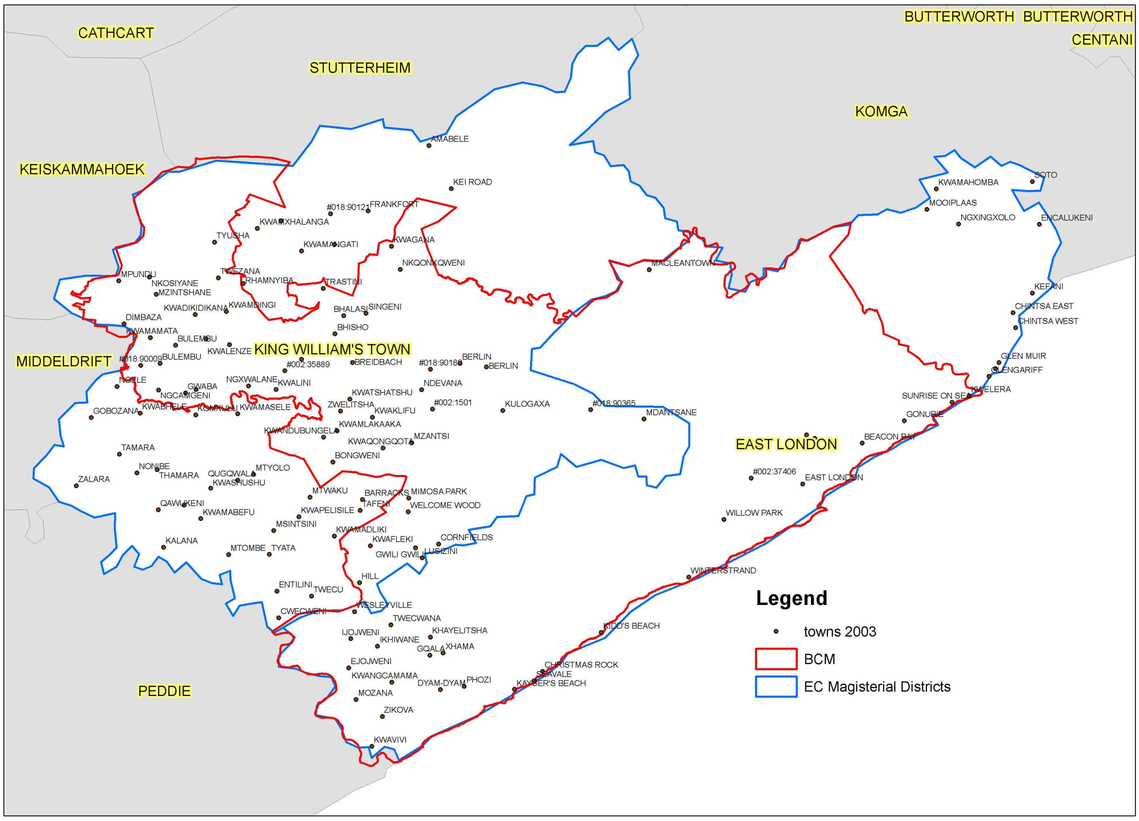



**Figure 6: The degree of overlap between current BCM Boundaries and former King Williamstown and East London Boundaries.**

(a) Paraffin

SAPIA "Construction" and "SAPIA "Remainder of General Trade" figures for paraffin were grouped under Industry and Commerce: Total in the Energy Balance.
A slightly lower paraffin total supply to BCM was adopted, in that the boundaries of SAPIA area of reporting exceed the boundaries of BCM.

(b) LPG

A disaggregation of LPG supply into household and other sectors was not available. An even split between household and commercial and industrial consumption was adopted.

## 4.6 Data Gaps

The following is a summary of data gaps:

- Disaggregated electricity demand in terms of Industrial, Commercial and Government Sectors;
- Petrol and Diesel consumption in the domestic sector (private generators);
- Diesel demand by the industrial sector (apart from construction);
- Disaggregated LPG demand into Domestic and Other Sectors;
- Fuelwood supply; and
- Updated data on Coal supply and demand.

## 4.7 Summary

The table below gives a summary of data issues and gaps. A level of confidence has been attributed to each value in the table to give an idea of the comparative level of reliability or disaggregation of the data. Values in green are considered to be reliable. Values in orange do not necessarily fit the categories defined in the energy balance, or have been extrapolated from other data. Values in red are out of date or are from tenuous sources.

**Table 6: Energy balance showing level of confidence of values in each category.**

| Energy Source | Household | Agriculture | *Mining* | *Industrial* | *Commercial - including service industries.* | Industry and commerce TOTAL | Gov Institutions (schools, hospitals, prisons, bisho) | Local Authority | Transport | Total | *Unit* |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Electricity municipal coal/nuclear/gas source | BCM Data | | | | Includes government services. | | | | | | *Kwh* |
| Electricity municipal coal/nuclear/gas source | 387,891,651 | | | 650,457,503 | 86,118,491 | 736,575,993 | | 41,604,168 | | **1,166,071,812** | *kwh* |
| Electricity municipal renewable source | | | | | | | | | | **0** | *kwh* |
| Electricity eskom coal/nuclear/gas source | 50,968,235 | 6,857,228 | 1,184,901 | | | 59,937,491 | | 2,670,387 | 3,945,688 | **125,563,930** | *kwh* |
| Electricity eskom renewable source | | | | | | | | | | **0** | *kwh* |
| **Electricity city total** | **438,859,886** | **6,857,228** | **1,184,901** | **650,457,503** | **86,118,491** | **796,513,484** | | **44,274,555** | **3,945,688** | **1,291,635,742** | **kwh** |
| Petrol | | 97,847 | | | | | 9,733 | 813,990 | 201,321,415 | **202,242,985** | *litre* |
| Diesel | | 9,430,238 | 17,149 | | | 1,206,717 | 17,051 | 1,001,515 | 133,380,045 | **145,052,715** | *litre* |
| Paraffin | 17,226,480 | 3,609,506 | 2,000 | | | 23,433,674 | | | 623,937 | **44,895,597** | *Litre* |
| LPG | 534,152 | | | | | 534,152 | | | | **1,068,303** | *m3* |
| Jet fuel | | | | | | | | | 16,328,376 | **16,328,376** | *litre* |
| HFO | | | | | | 9,092,014 | | | | **9092014** | *litres* |
| Biodiesel | | | | | | | | | | **0** | *litre* |
| Fuelwood | 10,422,274 | | | | | | | | | **10,422,274** | *kg* |
| Coal | 475,800 | | | 60,400,000 | 540,000 | 68340000 | 600,000 | | | **69,415,800** | *kg* |
| Natural Gas | | | | | | | | | | **0** | *kg* |
| Other energy sources (e.g. off-grid renewable) | | | | | | | | | | **0** | |

| | | | |
|---|---|---|---|
| **Key:** | High level of confidence: Reliable source, data fits category well | Medium confidence: Data extrapolated, or data does not precisely fit category. | Low level of confidence: Data out of date or from tenuous sources. |

## 5 ENERGY SUPPLY

### 5.1 Integrated picture of energy supply

Energy supply takes a number of forms, including electricity, liquid fuels, LPG and natural gas, coal and biomatter. However, each energy form has a different energy value with respect to its physical mass or form. For example one kilowatt of electricity contains a different amount of energy in comparison to a litre of diesel or a kilogram of coal. Therefore, in order to be able to compare the different energy forms, the different sources are expressed in a comparable unit, namely Gigajoule ($10^9$ joules[3]).

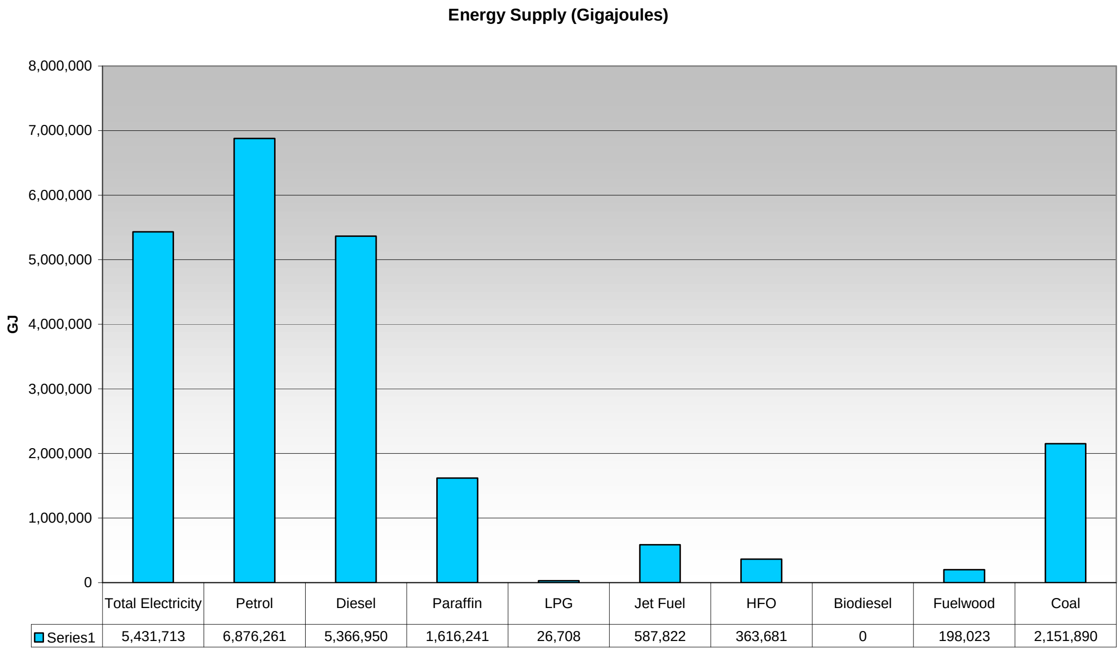



**Figure 7: Integrated energy supply to BCM in 2007, expressed in Gigajoules.**

Figure 30 illustrates the form of energy supplied to BCM in 2007. By far the biggest quantity of energy supplied to the municipal area was in the form of liquid fuels. Petrol, diesel, and jet fuel amounted to 12,831,033 Gigajoules, or 56.7% of the energy mix of BCM (see Table 7). In comparison, electricity supplied within BCM amounts to only 24% of the energy mix within the municipality.

**Table 7: Percentage energy supply to BCM in 2007, expressed in Gigajoules.**

| Energy Type | Gigajoules | Percentage |
|---|---|---|
| Total Electricity | 5,431,712.8 | 24.0 |
| Petrol | 6,876,261.5 | 30.4 |
| Diesel | 5,366,950.5 | 23.7 |
| Jet Fuel | 587,821.5 | 2.6 |
| Paraffin | 1,616,241.5 | 7.1 |
| LPG | 26,707.6 | 0.1 |
| HFO | 363,680.6 | 1.6 |
| Biodiesel | 0.0 | 0.0 |
| Fuelwood | 198,023.2 | 0.9 |

[3] One joule is the equivalent of one watt-second. It is the amount of work done when one Newton weight is lifted over a distance of one metre.

| Energy Type | Gigajoules | Percentage |
|---|---|---|
| Coal | 2,151,889.8 | 9.5 |
| Natural Gas | 0.0 | 0.0 |
| **Total** | **22,619,288.91** | **100** |

Figure 8 illustrates the tons of $CO_2$ emitted to the atmosphere through the consumption of the different energy types supplied to BCM. Although electricity constitutes only 24% of energy supplied to BCM, it is responsible for 56.9 percent (or 1,659,931 tons per year) of $CO_2$ emitted to the atmosphere (see Table 8). This is due to the fact that South Africa relies heavily on fossil fuels in the generation of electricity.

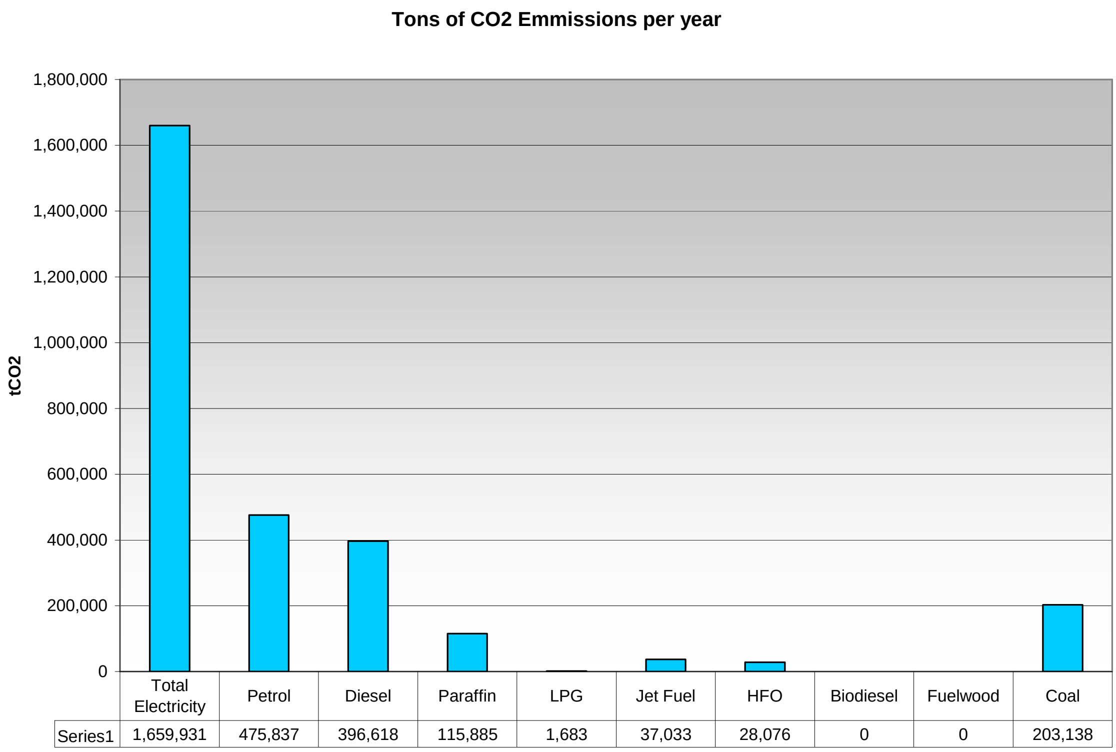



**Figure 8: Global $CO_2$ emissions resulting from consumption of different energy types within BCM in 2007 (expressed on tons of $CO_2$).**

Emissions related to transport (namely petrol, diesel and jet fuel) are responsible for 31.2% of emissions or 909,487 tons of $CO_2$ emitted in 2007. Note that fuelwood has been excluded as a source of emissions since this is considered a renewable source of energy (if harvested sustainably).

**Table 8: Percentage $CO_2$ emissions by fuel type supplied to BCM in 2007.**

| Fuel Type | Tons $CO_2$ Emitted | Percent |
|---|---|---|
| Total Electricity | 1,659,931.4 | 56.9 |
| Petrol | 475,837.3 | 16.3 |
| Diesel | 396,617.6 | 13.6 |
| Jet Fuel | 37,032.8 | 1.3 |
| Paraffin | 115,884.5 | 4.0 |
| LPG | 1,682.6 | 0.1 |
| HFO | 28,076.1 | 1.0 |
| Biodiesel | 0.0 | 0.0 |
| Fuelwood | 0.0 | 0.0 |
| Coal | 203,138.4 | 7.0 |
| **TOTAL** | **2,918,200.8** | **100.0** |

## 5.2 Electricity Supply

In 2007, 1,508,809,111 kilowatt-hours of electricity was supplied to the users within the boundaries of BCM. The major proportion of this amount, namely 92%, or 1,383,245,181 kilowatt-hours, was supplied to the municipality for distribution (see Figure 9). A smaller proportion, namely 8%, or 125,563,930 kilowatt-hours, was supplied directly to customers, including Large Power Users (LPUs), Small Power Users (SPUs) and Prepaid Power Users (PPUs).

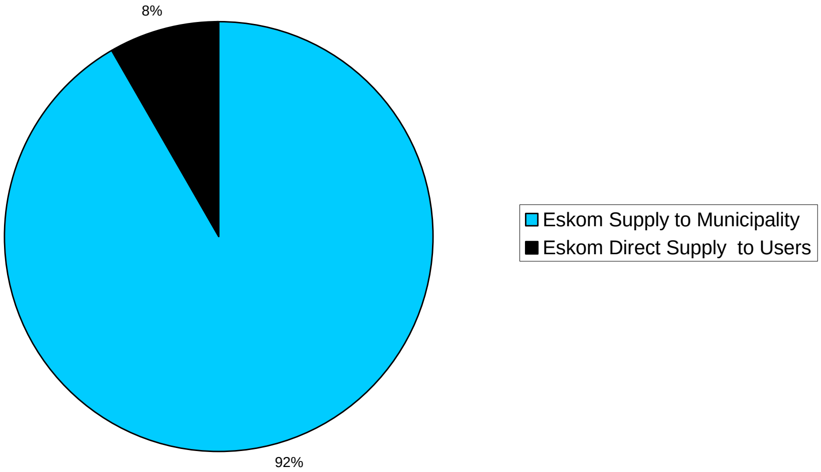



**Figure 9: Electricity supplied to BC M municipality as against electricity supplied directly to customers in BCM (2007)**

Electricity supply to the municipality has increased gradually from year to year. Table 9 shows that supply increased from 1,213,689,461 kwh in 2003 to 1,383,245,181 kwh in 2007. This represents a 13.9% increase in 5 years.

**Table 9: Annual electricity supply to BCM (municipal supply) from 2003 to 2007)**

| Year | Annual Supply (kwh) |
|---|---|
| 2003 | 1,213,689,461 |
| 2004 | 1,325,179,628 |
| 2005 | 1,327,430,299 |
| 2006 | 1,339,294,762 |
| 2007 | 1,383,245,181 |

The increase in supply is further illustrated in Figure 10. Apart from the gradual and obvious increase in supply, Figure 10 also shows a seasonal variations in supply, with lowest supply in December, associated with warm weather and reduced industrial and commercial demand over the Christmas Season, and highest supply in June and July, associated with colder winter weather.

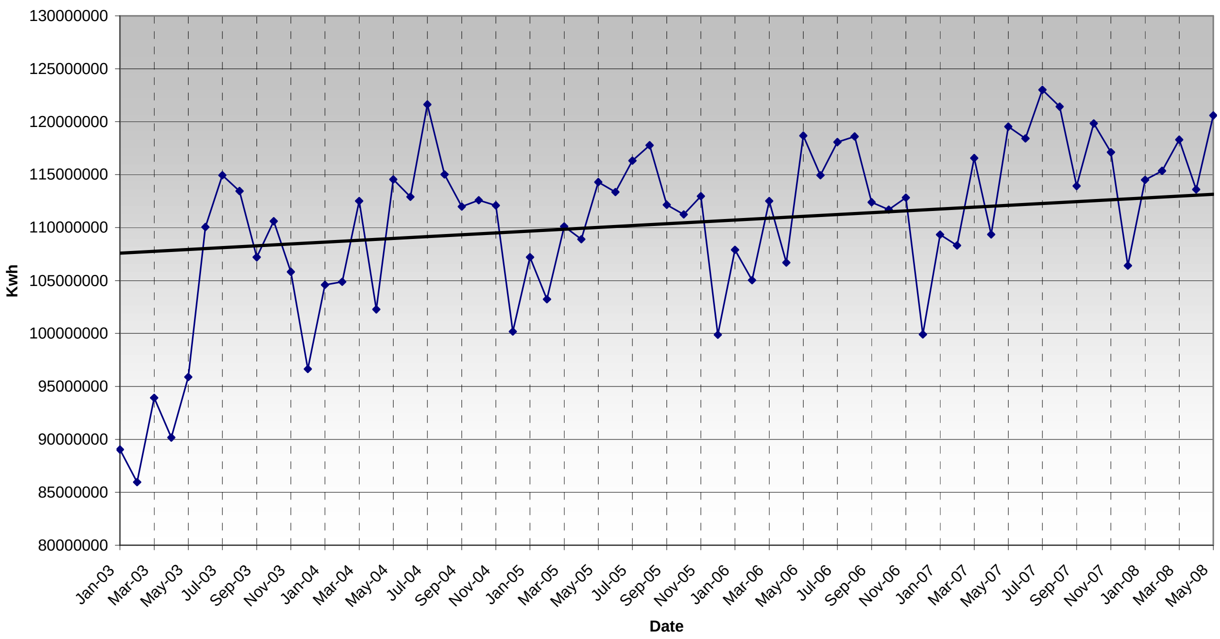
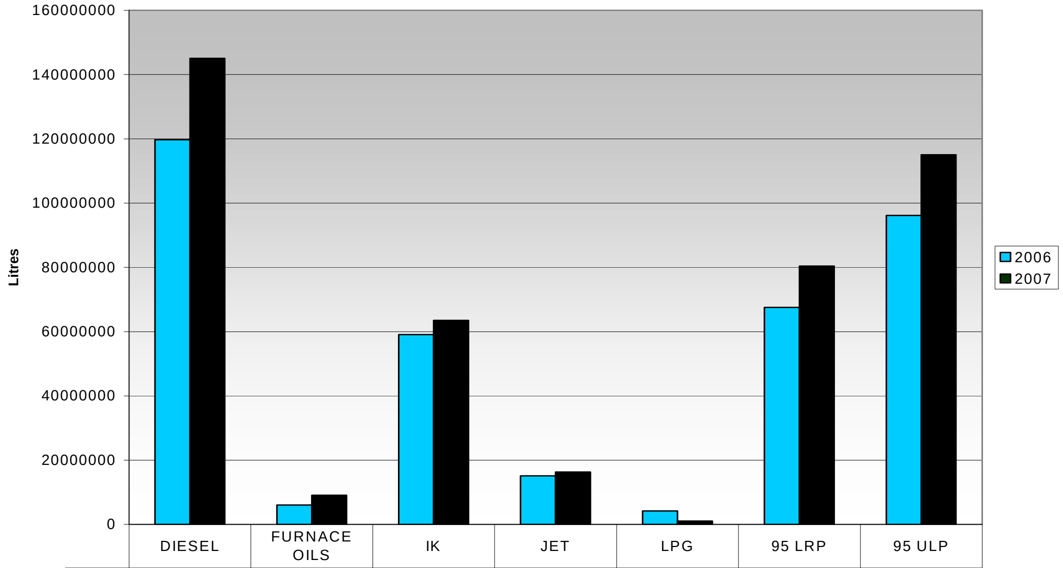



**Figure 10: Kilowatt-hours of electricity supplied to BCM by Eskom on monthly basis from Jan 2003 to May 2008**

The institutional nature of electricity supply is in the process of review in South Africa. The Eskom Amendment Act (1998) and the Eskom Conversion Bill of 2000 has set the foundation for the privatisation of Eskom and the establishment of 6 Regional Electricity Distributors (REDs). The REDs will subsume municipal electricity supply, resulting in certain municipal financial implications.

## 5.4 Liquid Fuels

A total of 430,561,013 litres of liquid fuel was delivered to the East London and King Williams Town area in 2007. The greater proportion of fuel was in the form of diesel and petrol (340,531,304 litres), representing 79% of total liquid fuels
Figure 11). Between 2006 and 2007, fuel supplies increased by 17%, with diesel increasing by 21% and petrol increasing by 19%. Heavy Fuel Oil increased by 50%. The exception to this trend was LPG gas, which decreased by 75%.




| | DIESEL | FURNACE OILS | IK | JET | LPG | 95 LRP | 95 ULP |
|---|---|---|---|---|---|---|---|
| 2006 | 119728909 | 6078035 | 59078798 | 15101793 | 4208707 | 67507709 | 96172443 |
| 2007 | 145052715 | 9092014 | 63541016 | 16328376 | 1068303 | 80414744 | 115063845 |

**Figure 11: Liquid fuel supplies to East London and King Williams Town (2006 and 2007)**

## 5.5 Coal

The best available figures for BCM show that 69,415,800 kilograms of coal was sold within BCM in 2004. This was almost entirely sales to industry and services. The Stats SA 2007 Community Survey shows that only 732 households in BCM used coal for domestic purposes such as heating.

In comparison to other energy sources in BCM, coal was responsible for 9.5% of the energy mix in BCM, and for 7% of global $CO_2$ emissions.

## 5.6 Biomass

### 5.6.1 Fuelwood

No data are available that show the supply of quantities fuelwood to BCM. It is likely that in rural areas fuelwood is collected locally, while in urban areas fuelwood is purchased from outside. However no figures for sale of fuelwood in urban areas are available. In this report, the amount of fuelwood used in BCM is extrapolated from national case studies and household fuelwood use statistics from the Stats SA 2007 community survey.

### 5.6.2 Other Biomass

No data are available regarding the use of biomass other than fuelwood in BCM. It is known that crop or plantation residue such as Bagasse or Sawdust is used in other provinces and districts. The Stats SA 2007 community survey shows that 173 households in BCM burn animal dung for heating in BCM.

## 5.7 Other sources of renewable energy

Although there are a number of initiatives currently under investigation, or planned for BCM, there are currently no known sources of renewable energy generation or supply within BCM.

(amatola green power supply to MBSA?)

## 5.8 Energy Supply Issues

- BCM has a heavy reliance on electricity generated from low-grade coal, causing high levels of greenhouse gas emissions.
- The effects of amalgamating Eskom and numerous municipal electricity supply entities into one RED is unclear. This means that electricity and energy forward planning is hampered.
- Electricity distribution infrastructure within BCM is becoming aged. MFMA does not link electricity tariffs with reinvestment in infrastructure.
- Energy supply to BCM is dominated by far by fossil fuels. Fossil fuels are becoming increasingly expensive, which threatens the energy security of the city.
- Half the energy supply in BCM is for transport (petrol and diesel). To effectively improve the efficiency of energy consumption in the municipality, the transport sector should receive attention.

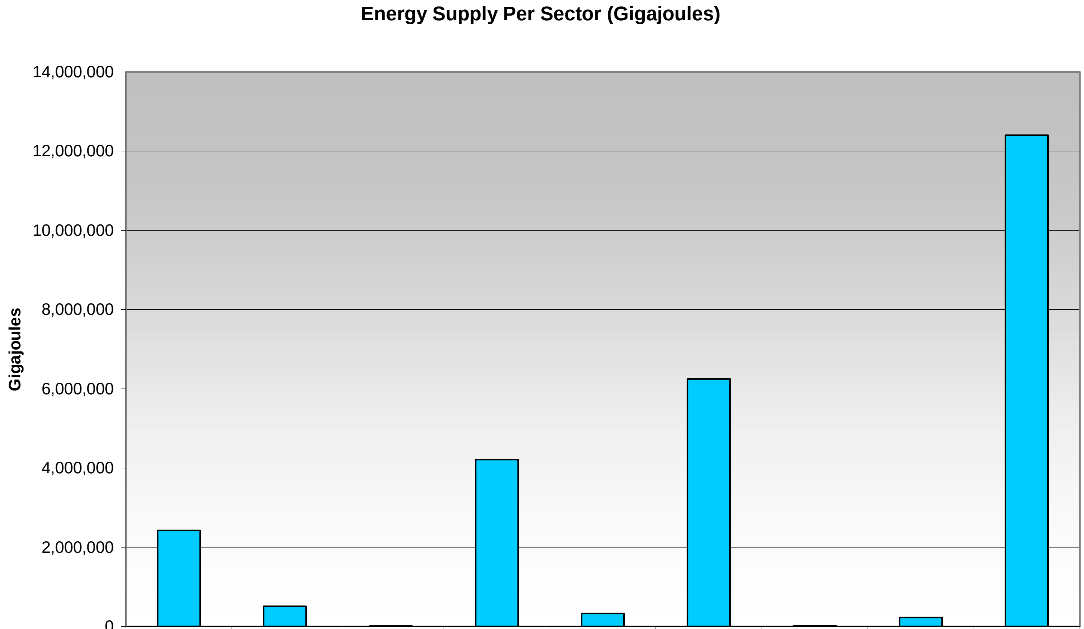
## 5.9 Demand

The next four chapters deal with the nature of energy demand by sector. Particular sectors focussed upon are:

- Local Authority;
- Household;
- Commerce and Industry; and
- Transport.

Sectors that have not been included under a specific chapter are agriculture, mining and national and provincial government institutions (prisons, hospitals, schools etc).

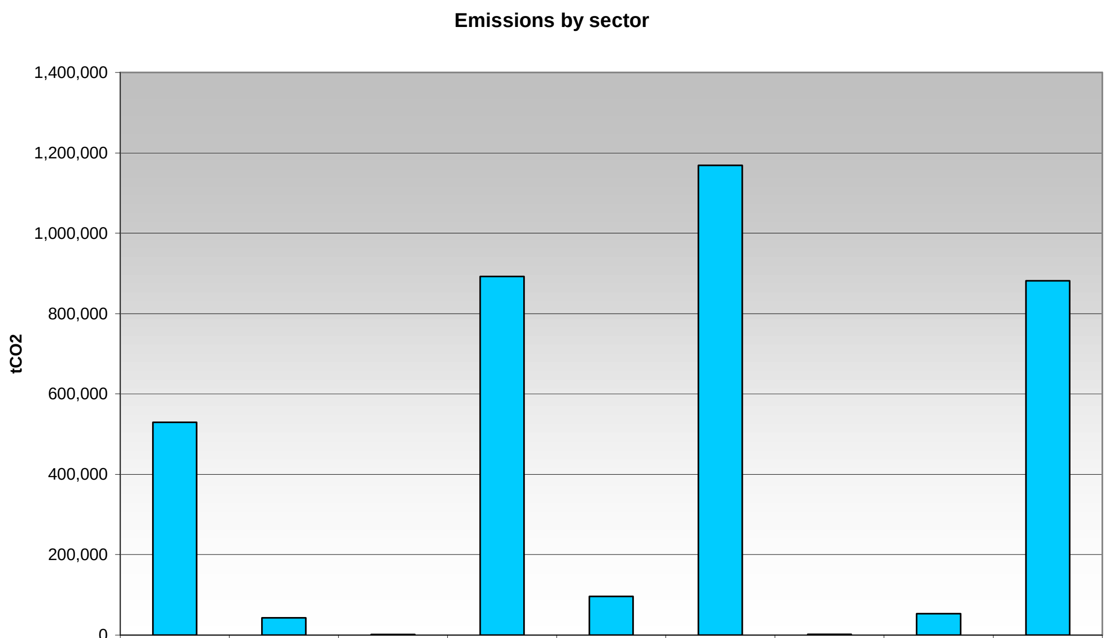
Figure 12 shows more than half the energy was consumed by the transport sector, a little over a quarter was consumed by the industrial and commercial sectors, and roughly a tenth was consumed by households. Only 1% of the energy was consumed for municipal functions such as street lighting, water and sanitation services, municipal buildings, and municipal fleets.




| | Household | Agriculture | Mining | Industrial | Commercial - including service | Industry and commerce TOTAL | Gov Institutions (schools, | Local Authority | Transport |
|---|---|---|---|---|---|---|---|---|---|
| Series1 | 2,426,176 | 506,874 | 4,972 | 4,214,047 | 326,767 | 6,251,284 | 19,562 | 224,120 | 12,404,478 |

**Figure 12: Energy consumption by sector.**

Figure 13 shows that despite the large energy consumption in the transport sector, it is only responsible for 33% of global $CO_2$ emissions released by BCM. The sector responsible for most emissions is industry and commerce, at 43.6%. Residential households, while only consuming 10% of energy in BCM, are responsible for 19.8% of BCM emissions.




| | Household | Agriculture | Mining | Industrial | Commercial - including service | Industry and commerce TOTAL | Gov Institutions (schools, | Local Authority | Transport |
|---|---|---|---|---|---|---|---|---|---|
| Series1 | 529,515 | 42,876 | 1,356 | 892,362 | 96,324 | 1,168,986 | 1,825 | 53,363 | 881,354 |

**Figure 13: Carbon Dioxide emissions by sector (tons of Carbon Dioxide per year)**

# 6 TRANSPORT SECTOR

## 6.1 Introduction

This chapter examines the energy profile of the Transport Sector that falls within the Buffalo City Municipal region.

## 6.2 Sector Energy Profile within South Africa and Eastern Cape

Typically the transport sector account for about 24% of the total energy consumption in South Africa. More than 90% of transport energy is derived from liquid fuels. Since the supply of these fuels is largely dependant on crude oil imports, transport energy is unusual in that its pricing is heavily influenced by international supply and demands.

## 6.3 Sector Energy Profile in BCM

Buffalo City's Transport picture is similar to many South African cities where public transport dominates in terms of modal splits. Transport is characterised by a high car usage amongst the economically well-off population, while people with low income have to rely on public transport or must walk.

The fragmented nature of the built environment, particularly in the rural areas, impacts negatively on the mobility of Buffalo City residents. Access to higher order areas from the rural more distant areas for both social activities and economic opportunities greatly influences the transport network pattern. Approximately 25% of income of poor is spent on transport.

A travel survey undertaken for the development of the Integrated Transport Plan indicated that an estimated total of 1.6 million trips per day are made in the functional transport area of which 50% are made on foot. Motorised trips total 0.8 million trips per day of which 62% are undertaken by public transport (mostly minibus taxis).

Of all motorised trips made in Buffalo City public transport accounts for 62% of trips compared with 38% by private car, and is therefore an important means of travel for the majority of citizens of Buffalo City. Surveys carried out in 2002 indicate that of the 300 000 trips made using public transport each day, 250 000 are made by taxi, 25 000 by scheduled conventional bus and 25 000 are made by passenger rail. (Integrated Transport Plan).

### 6.3.1 Road Transport

A total of 191 355 vehicles were registered in Buffalo City Municipality in 2004. This figure had increased relative to 2002 and 2003, when the number of vehicles registered were 164 447 and 177 308 vehicles respectively. This indicates an annual increase of vehicle ownership of approximately 8% per annum, considerably higher than the growth in population, which is about 2% per annum. If this trend is to continue to 2010 as is likely, it would be expected that over 300 000 vehicles (a growth of 50% in six years) will be registered in BCM by that date.

Buffalo City has an estimated 1230 km of roads.

The high number of vehicles in BCM (approx. 0.27 cars per person) has created traffic congestion in certain areas at certain times. High energy inefficiency is experienced in congested traffic with standing vehicles. The city is implementing a roundabout strategy to release congestion and reduce travel speeds.

### 6.3.2 Public Transport

This section provides a brief overview of Buffalo City's public transport system. Most of the information provided in this chapter has been extracted from the Buffalo City Integrated Transport Plan and discussions with representatives from the BCM Transport Planning Department. Over 70% of the population in Buffalo City are dependent on public transport and it is therefore imperative that high-density housing development and work opportunities are provided in close proximity to public transport routes.

### 6.3.3 Minibus Taxi Industry

Minibus taxi services dominate the public transport system in Buffalo City. The minibus taxi industry has positioned itself to serve most of the functional transport area and has, in turn, developed a unique character in itself. Local feeder routes have been established in all the low to middle income urban residential areas. These local feeders carry passengers to a few large taxi ranks from where minibus taxis operate routes to other taxi ranks/destinations.

The type of minibus taxi service provided also relates strongly to the areas that are served. Conventional 16-seater minibus taxis are used mainly on the surfaced roads in the main transport corridors, such as Mdantsane – East London or King William's Town – Zwelitsha and in the internal routes within the urban area. There is a trend towards the use of sedans as minibus taxis and this is a clear sign of the deterioration of the system. Bakkie taxis are found predominantly in the King William's Town area where they provide an invaluable service to the rural villages situated to the north, west and south of King William's Town. These bakkie taxis are used mainly on the gravel roads that are in most cases not suited for use by conventional minibus taxis or sedans.

The following table presents the estimated vehicle numbers that participate in the private taxi industry:

**Table 10: Estimated numbers of taxi's operational in BCM.**

| Vehicle type | No. of vehicles | Capacity/ vehicle | Total no. of seats |
|---|---|---|---|
| Sedan "taxis" | 780 | 4 | 3120 |
| Minibus taxis | 1600 | 15 | 24000 |
| Bakkies | 240 | 10 | 2400 |
| Unconfirmed | 600 | 12? | 7200 |
| Total | 3220 | | 36000 |

The table shows that there is an estimated 3220 vehicles that operate in the taxi industry of which only 2000 are formally registered, making the remainder illegal.

### 6.3.4 Bus operations

Bus operations carry less than 10% of the total public transport and offer a social service mostly for rural areas and part of the East London area.

Contracted bus services currently play a relatively small role in Buffalo City in comparison with the minibus-taxi industry. Mayibuye, a provincially-owned and subsidised company, operates some limited services within the municipality operating mainly to rural and peri-urban destinations including Mdantsane and King William's Town / Bisho. The depots in Reeston and Mayibuye operate 18 and 39 buses respectively, servicing a total of 42 routes in the area.

Mayibuye Transport Corporation is a state bus company that was established in 1990 after the demise of the Ciskei Transport Corporation.

The Buffalo City–owned municipal bus company has a permit for 33 buses, and provides a social service covering schools and pensioners within the confines of the old East London area. Most of the buses are over 20 years old. The service has only 19 buses are operated on 46 routes from the bus depot in Dyer Street. It carries relatively few passengers (Integrated Transport Plan).

In addition to the scheduled bus services, there are an at least 38 private bus operators who operate unscheduled services in the same manner as minibus taxis operate in Buffalo City.

### 6.3.5 Rail Transport

The rail network in the Buffalo city area was traditionally planned around servicing industry rather than as public transport initiative. As a result of apartheid planning, there is no direct rail link between East London and Durban or Port Elizabeth which means freight travels by road between these economic centres and is essentially energy inefficient.

The South African Rail Commuter Corporation currently operates 7 trainsets in Buffalo City, providing about 10 peak-period passenger rail service trips in the peak direction on weekdays, 4 on Saturdays and none on Sundays. These operate according to regular scheduled services on the line between Berlin and East London.

This is the only commuter rail service in Buffalo City and is operated between Berlin and East London, a distance of 41 km. There are 18 stations, East London and Berlin included, and the average distance between the stations is 2.5 km.

The main East London – Berlin railway track is a double track with a general speed restriction of 90km/h. Diesel locomotives are currently used but are not suited to optimal operation in these circumstances and this translates to abnormally long travel times.

The track is of sufficient standard for a commuter service. East London – Berlin is electrified with 25 kV AC supplied by two sub-stations (East London-Egerton and Fort Jackson-Berlin), each fed by a single phase supplied by Eskom. The electrical power supply is not the standard system for commuter rail in South Africa (3 kV DC) and the normal electric motor coaches used for commuter rail in other South African cities can therefore not be used. The annual diesel consumption by Metrorail for the East London train system is tabulated in Table 11.

**Table 11: Annual fuel quantities utilised by Metrorail**

| Fuel Type | Diesel |
|---|---|
| Quantities in litres per year[4] | 113904 |

[4] Based on an average price of R6.90 per litre for Petrol and R   for diesel for 2007.

### 6.3.6 Travel Time

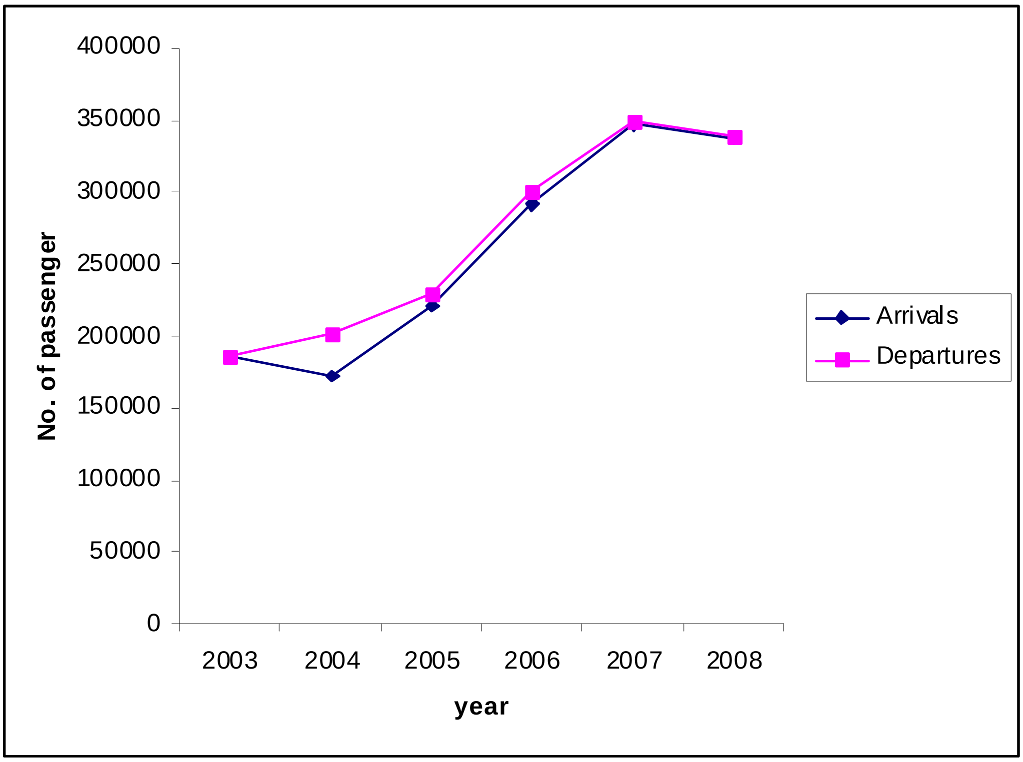
Previous surveys undertaken show that the average travel time to work is in the vicinity of 21 minutes, with a longer travel time for public transport and a shorter travel time for private transport. This affects the desirability of public transport as opposed to private cars in terms of time saving.

**Table 12: Average travel time to work per mode of transport within BCM (BCM Transport Plan)**

| Mode | Average travel time (minutes) |
|---|---|
| Car | 17 |
| Walk | 19 |
| Minibus taxi | 26 |
| Bus | 27 |
| Train | 32 |
| Average | 21.5 |

### 6.3.7 Air transport

The East London Airport is the main departure point for all air traffic in the Buffalo City area with minor activity out of Bhisho airport. Current East London air traffic is at 70% utilisation of available seats. However the numbers of passengers arrivals and




departures has shown a steady increase.

**Figure 14: No. of passenger arrivals and departures out of East London Airport[5]**

[5] Figures for the month of March for the 2008 year are excluded as this data was not yet available Hence the slight decline in passengers recorded for this period.

Annual jet fuel quantities utilised by aircraft leaving the East London airport are included in Table 13.

**Table 13: Estimated annual fuel quantities utilised by aircraft out of East London Airport**

| Fuel Type | Jet A1 fuel |
|---|---|
| Quantities in litres per year[6] | 15 600 000 litres |

### 6.3.8 Freight transport

Freight transport within BCM is mainly via road which not only has negative impacts on road pavements but also creates safety health and hazards and creates unnecessary maintenance costs.

Some freight leaves via the East London Airport where the reported quantities are low and average at 350 tons per month (P.E. 970 tons per month). (City development strategy).

The Port of East London currently imports mostly vehicle components, maize products, wheat, machinery, cement, chemicals, sugar, timber, textiles. Main exports include motor vehicles and components, maize, processed pineapple products and scrap steel.

Annual cargo volumes for the Port are illustrated in Figure 15. It can be seen that there is a slight increase in quantities of cargo handled with 1832894 metric tons of cargo handled in 2007. The number of vessels entering the Port has decreased slightly (Figure 16) which effectively implies that there is increased efficiency in terms of transport through the port.

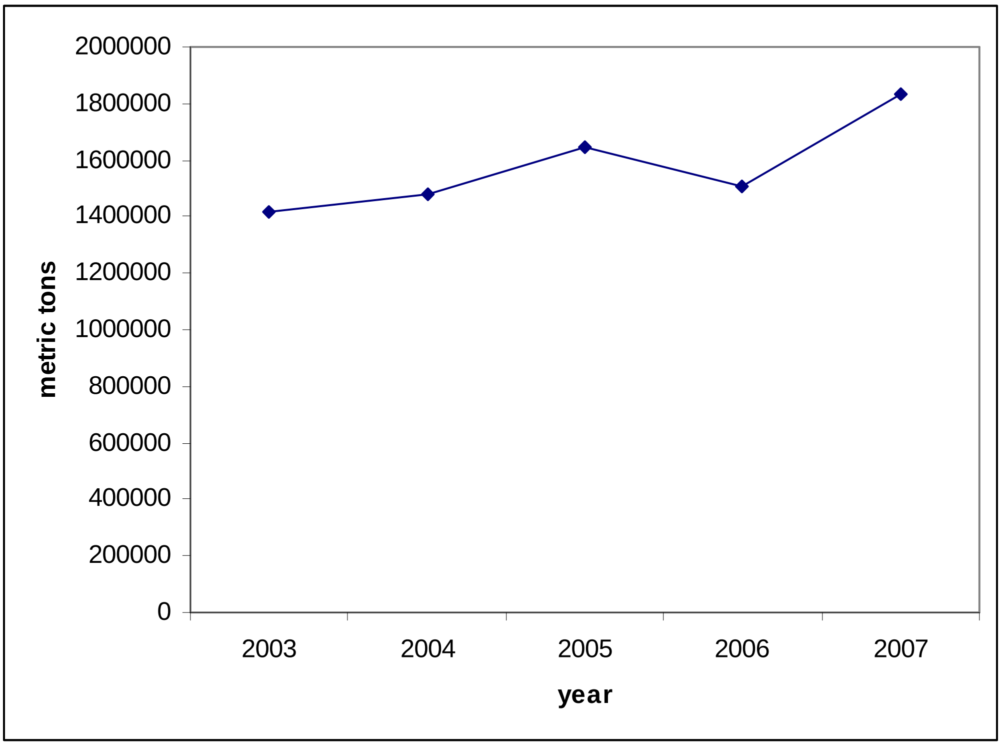



**Figure 15: Annual quantities of cargo handled through the Port of East London.**

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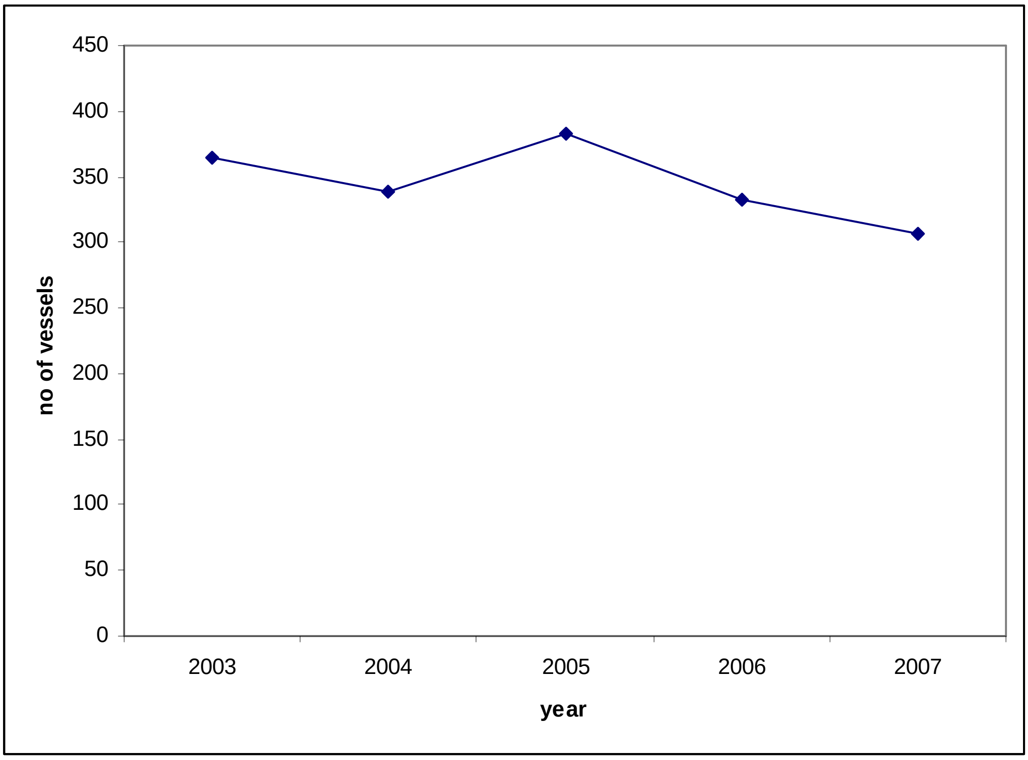



**Figure 16: Annual numbers of vessels arriving in the Port of East London.**

Although a ship fuel line exists for refuelling ships off the Port of East London, this facility has not been utilised for the past five years (pers.comm. Thys Coetzee NPA) and hence there is no measure of fuel quantities utilised by the ships themselves.

### 6.3.9 Non-motorised transport

A significant number of people who do not have the means to use a private car or public transport for daily transport in Buffalo City gain access to work, education and other activities by walking (up to half of all trips made).

The use of the bicycle as a mode of commuter transport is currently negligible, even though there are many bicycle owners due to its popularity for recreation and sports activities.

The integration of pedestrian and bicycle facilities into the transport system promote improved accessibility to public transport interchanges and bus stops, work, school, shops, leisure etc. It promotes safer walking and bicycling – and it also contributes to an environmentally sustainable transport system as a whole. Non-motorized transport is an inexpensive means to make short trips within the City, and it also benefits personal good health and fitness.

## 6.4 Key Issues

BCM has replaced approximately 50% of traffic lights with LED bulbs. Initial establishment and maintenance costs are high. Additional funding is required to complete the installation process.

To combat load shedding and its effect on traffic congestion, BCM is in the process of purchasing UPS technology for traffic lights at key intersections, particularly near schools where morning congestion is high.

Over 70% of the population in Buffalo City are dependent on public transport and it is therefore imperative that high-density housing development and work opportunities are provided in close proximity to public transport routes.

The fragmented settlement pattern has obvious consequences for sustainability, requiring a more extensive and expensive transportation network and public transport system.

Buffalo City's 2020 transport vision is for an 80:20 modal split of public to private transport. The current modal split is in the region of a 60:40 ratio.

The recently completed Kei Rail project is a pilot project for Governments "Moving back to Rail Strategy"

Deficiencies in road infrastructure, lack of facilities for pedestrians and cyclists all impact on energy consumption (BCM IDP, 08/09).

## 6.5 Existing Responses and Initiatives

The recently completed Kei Rail project is a pilot project for Governments "Moving back to Rail Strategy" and presents further opportunities to reinstate rail an alternative more energy efficient public and freight transport initiative.

The BCM Transportation Division have set a strategic goal to have a modal split in terms of transport as 80% public : 20% private by 2020. Initiatives associated with this goal include:

- Improved rail service that will form the most important component of the "trunk" public transport network.
- Bus Rapid Transport (BRT) system is being planned for the city as a public transport alternative.
- Investment into cycle paths and pedestrian facilities

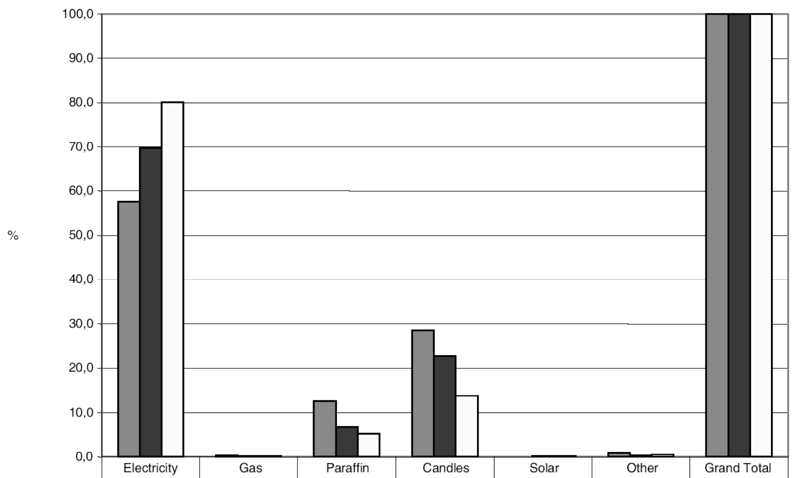
# 7 HOUSEHOLD ENERGY

## 7.1 Introduction

Household energy is most relevant to South African individuals because it directly affects their quality of living and day-to-day activities. Household energy is also the area where individuals can make the greatest difference in terms of promoting sustainable energy.

## 7.2 Household Energy Profile within South Africa and Eastern Cape

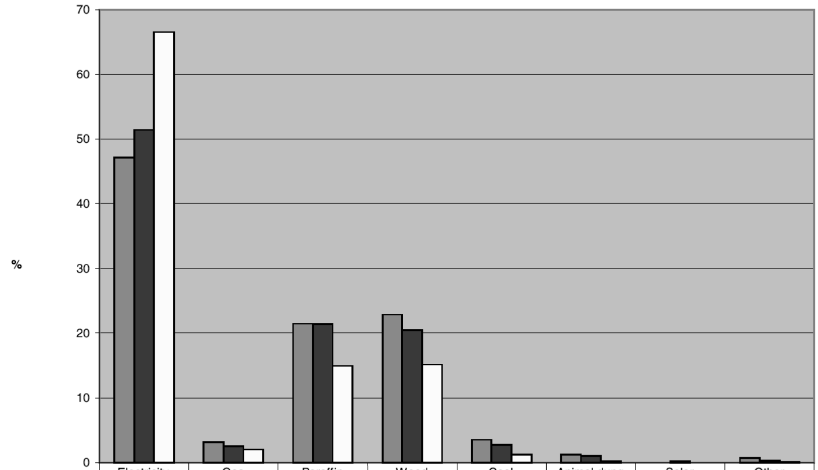
South Africa is characterised by a wide range of household types and associated energy consumption profiles. In 2006 58% of South Africa's population lived in urban areas. A large proportion of these people live in informal dwellings, or households not serviced by electricity. These households rely mostly on energy directly from fossil fuels, or from fuelwood. Figure 17, Figure 18 and
Figure 19 show that candles, paraffin, gas and fuelwood form an important element of national household energy consumption patterns. However, it can be seen that between 1996 and 2007, the supply of electricity to South African households has increased, resulting in a decrease in reliance on direct sources of energy.




| | Electricity | Gas | Paraffin | Candles | Solar | Other | Grand Total |
|---|---|---|---|---|---|---|---|
| Census 1996 | 57,6 | 0,4 | 12,6 | 28,5 | 0,0 | 0,8 | 100,0 |
| Census 2001 | 69,7 | 0,2 | 6,8 | 22,7 | 0,2 | 0,3 | 100,0 |
| CS 2007 | 80,0 | 0,2 | 5,3 | 13,8 | 0,2 | 0,5 | 100,0 |

**Figure 17: National patterns of household energy use: Energy for lighting (Source: Statistics South Africa, 2007)**

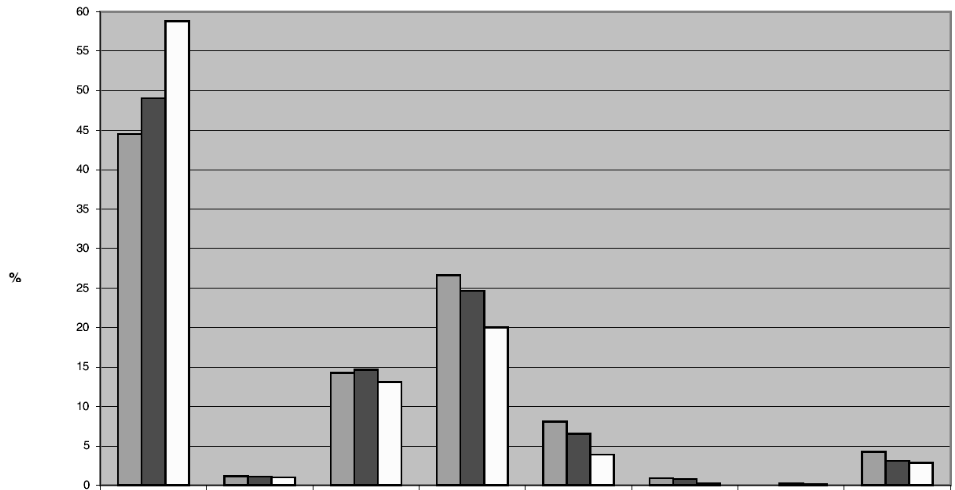
Figure 17 shows that the use of electricity for household lighting has increased from 57% in 1996 to 80% in 2007. Over the same period the use of paraffin decreased from 12.6 to 5.3% and candles from 28.5 to 13.8%.




| | Electricity | Gas | Paraffin | Wood | Coal | Animal dung | Solar | Other |
|---|---|---|---|---|---|---|---|---|
| Census 1996 | 47,1 | 3,2 | 21,5 | 22,9 | 3,5 | 1,2 | 0,0 | 0,7 |
| Census 2001 | 51,4 | 2,5 | 21,4 | 20,5 | 2,8 | 1,0 | 0,2 | 0,2 |
| CS 2007 | 66,5 | 2,0 | 14,9 | 15,1 | 1,2 | 0,2 | 0,0 | 0,1 |

**Figure 18: National patterns of household energy use: Energy for Cooking (Source: Statistics South Africa, 2007)**

Figure 18 shows that the use of electricity for cooking increased from 47% to 66.5% between 1996 and 2007. Paraffin and wood, although decreasing in importance, remain important as sources of energy for cooking at 14.9% and 15.1% respectively.




| | Electricity | Gas | Paraffin | Wood | Coal | Animal dung | Solar | Other |
|---|---|---|---|---|---|---|---|---|
| Census 1996 | 44,5 | 1,2 | 14,3 | 26,7 | 8,1 | 0,9 | 0,0 | 4,3 |
| Census 2001 | 49,0 | 1,1 | 14,6 | 24,6 | 6,6 | 0,7 | 0,2 | 3,1 |
| CS 2007 | 58,8 | 1,0 | 13,1 | 20,0 | 3,9 | 0,2 | 0,1 | 2,9 |

**Figure 19: National patterns of household energy use: Energy for Heating (Source: Statistics South Africa, 2007)**

Figure 19 shows that the use of electricity for heating has increased from 44.5 to 58.8% between 1996 and 2007. However paraffin and wood remain important sources of fuel for heating at 13.1% and 20.0% respectively. Notably the use of coal for heating has more than halved, decreasing from 8.1% to 3.9% between 1996 and 2007.

## 7.3 Household Energy Profile in BCM

In 2007, BCM had 208,388 households (see Figure 20). However, only 66.6% of these households where within permanent or acceptable dwellings (in other words brick homes, blocks of flats or cluster homes). In contrast, 27.6 % (57 764 households) were within in inadequate housing (namely rooms in back yards or shacks in back yards and informal settlements). This implies a housing backlog of roughly 60 000, although in 2004 the official housing backlog was 75 000 (IDP 2007). Generally informal houses are poorly linked to municipal services, including electricity supply. The converse implies that as formal housing increases as part of BCMs Social Housing commitments, so too will levels of electrification of households.

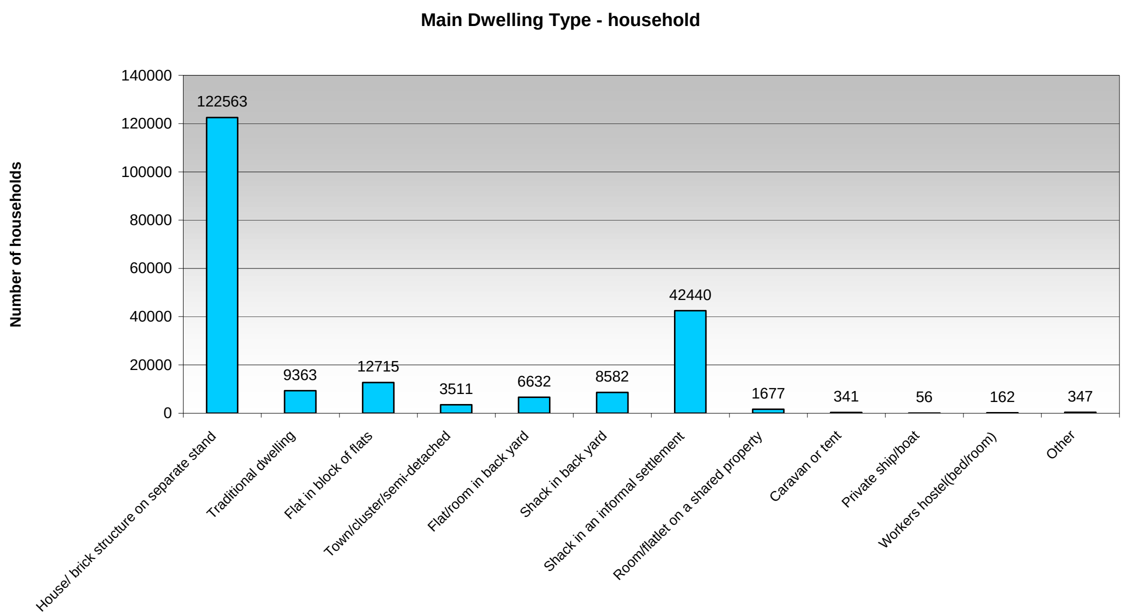
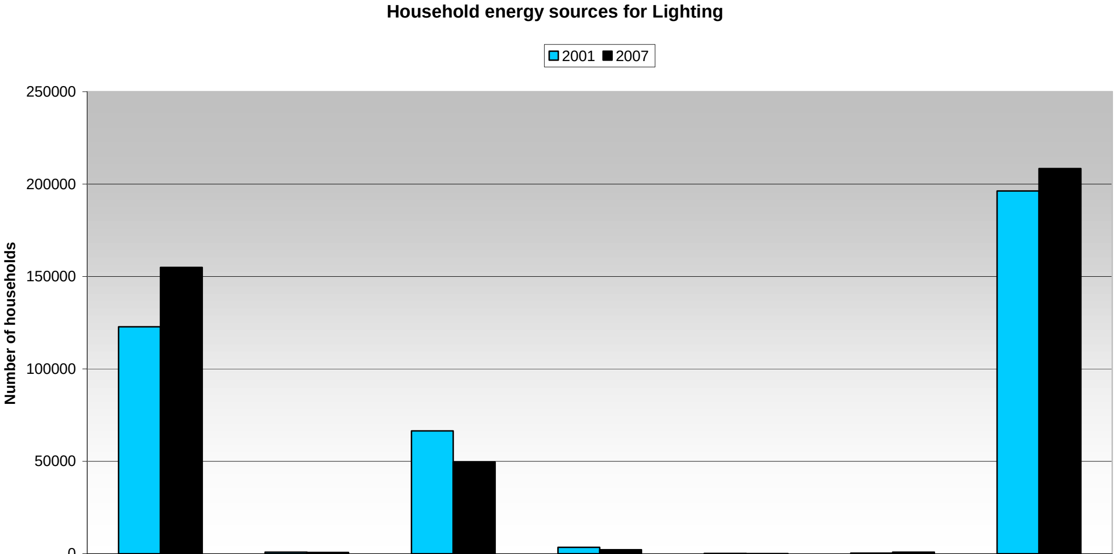



**Figure 20: Main household dwelling types within BCM (Source: Stats SA 2007)**

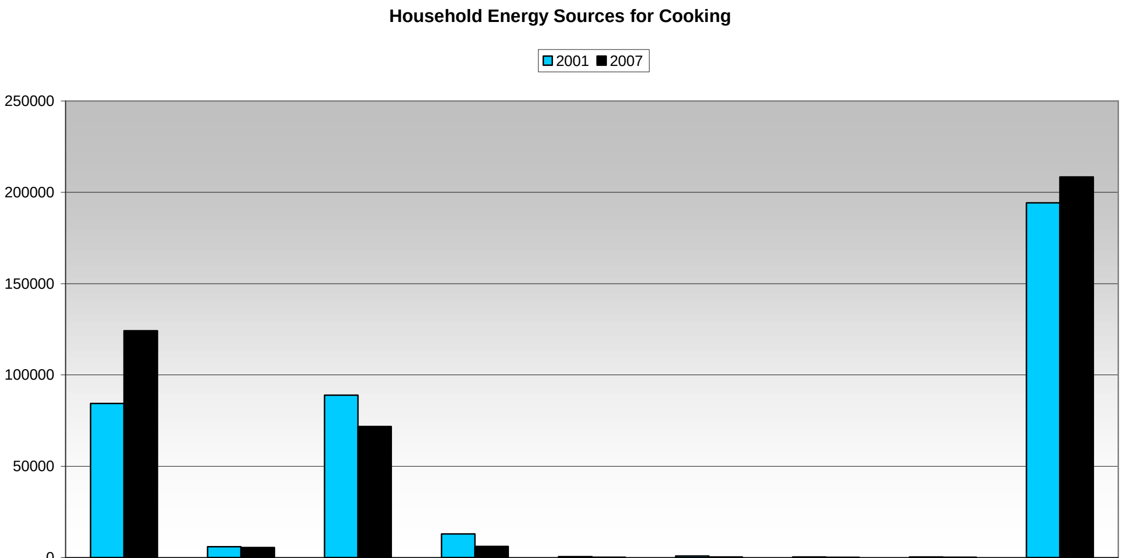
Figure 21 gives a break down of energy sources for lighting within households in BCM. Households using electricity for lighting increased from 62.6% in 2001 to 74.3% in 2007. In contrast, paraffin decreased from 33.8% in 2001 to 22.8% in 2007.

**Figure 21: Household Energy Sources for Lighting in BCM (Source: Stats SA 2007).**




| | Electricity | Gas | Paraffin | Candles | Solar | Other | Total |
|---|---|---|---|---|---|---|---|
| 2001 | 122757 | 916 | 66423 | 3553 | 199 | 404 | 196253 |
| 2007 | 154,877 | 724 | 49,642 | 2,164 | 60 | 921 | 208,388 |

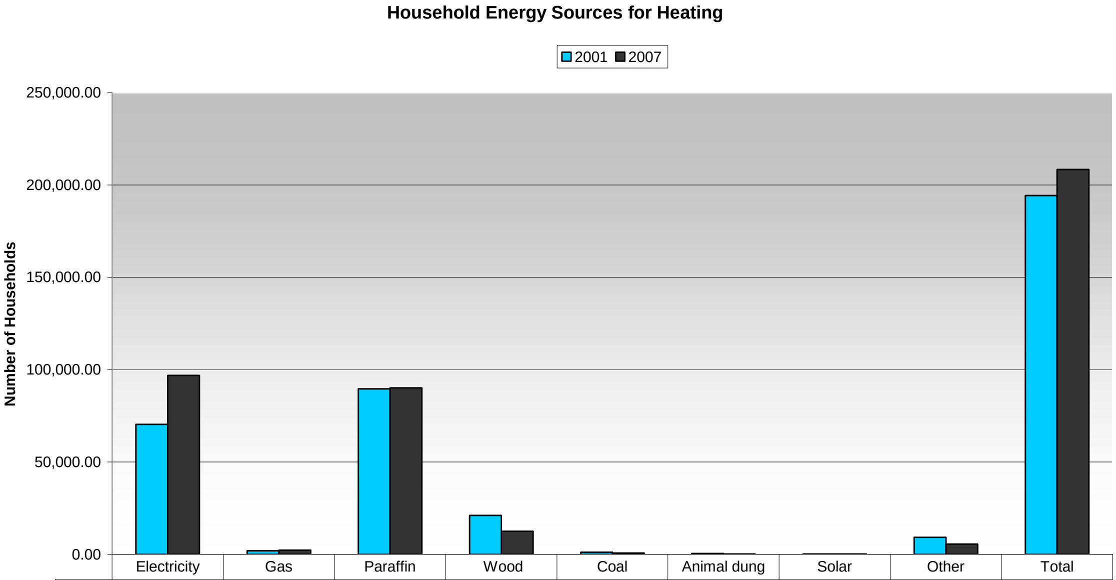
Figure 22 shows that households using electricity for cooking increased from 43.4% in 2001 to 59.6% in 2007. The use of paraffin decreased from 45.8% to 34.4%, while wood decreased from 6.7% to 3%, over the same period. It is notable that more households use electricity for lighting than for cooking. This may be due to the fact that households use their free monthly 50Kwh electricity allocation for lighting, while relying on other sources of fuel for more energy intensive cooking.




| | Electricity | Gas | Paraffin | Wood | Coal | Animal dung | Solar | Other | Total |
|---|---|---|---|---|---|---|---|---|---|
| 2001 | 84399 | 5893 | 89005 | 12926 | 521 | 909 | 287 | 310 | 194250 |
| 2007 | 124,172 | 5,501 | 71,777 | 6,170 | 151 | 326 | 60 | 232 | 208389 |

**Figure 22: Household energy sources for cooking in BCM (Source: Stats SA 2007).**

Figure 23 shows the sources of energy used for heating in households in BCM. Although the proportion of households using electricity for heating increased from 36.2% to 46.5% between 2001 and 2007, the use of paraffin effectively stayed the same. However, fuelwood decreased from 10.9% to 6.0% as a source of heating for households.




| | Electricity | Gas | Paraffin | Wood | Coal | Animal dung | Solar | Other | Total |
|---|---|---|---|---|---|---|---|---|---|
| 2001 | 70,375.00 | 1,942.00 | 89,633.00 | 21,139.00 | 1,208.00 | 531.00 | 189.00 | 9,231.00 | 194,248.00 |
| 2007 | 96,810.00 | 2,273.00 | 90,153.00 | 12,477.00 | 732.00 | 175.00 | 179.00 | 5,589.00 | 208,388.00 |

**Figure 23: Household energy sources for heating in BCM (Source: Stats SA 2007).**

Table 14 shows energy consumption of all households within BCM in 2007. Physical quantities (such as kwh and litres) are expressed in a comparable measure in terms of Gigajoules per year. The proportional energy consumption in Gigajoules is illustrated in Figure 24. Different types of energy cause different amounts of $CO_2$ emissions. For example one kilowatt of electricity used “causes” the release of 1.1 kg of $CO_2$ at the power stations. By the same token, the burning of 1 litre of paraffin causes the release of 2.6 kg of $CO_2$. The proportional $CO_2$ emissions released by the consumption of different energy types within BCM in a year is illustrated in Figure 25.

**Table 14: Total annual household energy consumption, expressed in Gigajoules, and associated Global Carbon Emissions, Expressed in Tons of Carbon Dioxide.**

| Energy Type | Quantity | | Gigajoules Per Year | Tons $CO_2$ Emissions per year. |
|---|---|---|---|---|
| Electricity | 438,859,886 | kwh | 1,579,896 | 482,816 |
| Petrol | 0 | litres | 0 | 0 |
| Diesel | 0 | litres | 0 | 0 |
| Paraffin | 17,226,480 | litres | 620,153 | 44,465 |
| LPG | 534,152 | $m^3$ | 13,354 | 841 |
| Fuelwood | 10,422,274 | kg | 198,023 | 0 |
| Coal | 475,800 | kg | 14,750 | 1,392 |
| Natural Gas | 0 | $m^3$ | 0 | 0 |
| **TOTAL** | | | **3,097,411** | **577,642** |

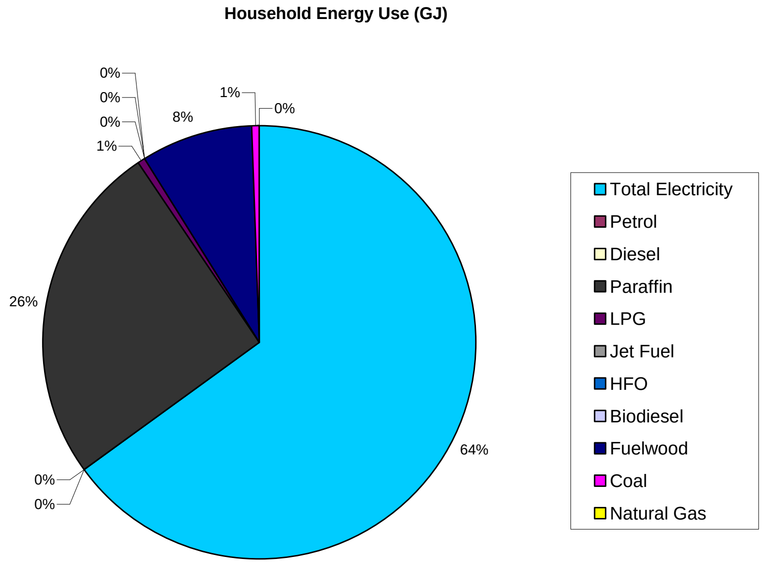



**Figure 24: Pie chart of percentages of household energy consumption by energy type.**

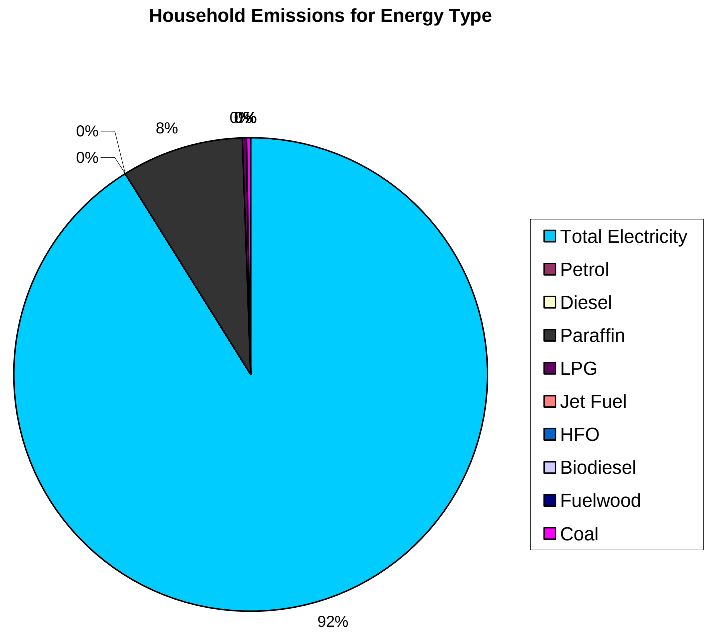



**Figure 25: Pie chart of percentages of total household Carbon Dioxide Emissions by energy type.**

### 7.3.1 Electricity

Table 14 shows that 438,859,886 kwh of electricity is consumed annually by households within BCM (2007/2008 figures). This translates to 1,579,896 gigajoules, which represent 64% of household energy consumed within BCM (Figure 24). However, 1,579,896 gigajoules of electricity produces 482,816 tons of $CO_2$ emissions. This represents 92% of all emissions caused by energy consumption by households within BCM (Figure 23). This means that although electricity is the safest and most convenient form of energy used by households, it is a heavier emitter of greenhouse gasses compared with other sources of energy per joule consumed. This is largely attributable to the large proportion of coal-powered stations making up the electricity generation mix in South Africa.

Electricity is supplied to households by both BCM Electricity (mainly in urban areas), and Eskom (mostly in rural areas). BCM supplies 387,891,651 kwh, while Eskom supplies 50,968,235 kwh. See Table 15 and Table 16 for details of the supply.

**Table 15: Characteristics of domestic electricity supply: BCM Electricity Department.**

| | Number of accounts | Monthly Consumption (kwh) | Average per User per Month (kwh) | Annual Total (kwh) |
|---|---|---|---|---|
| Domestic Prepaid | 85,806 | 21,842,969 | 255 | 262,115,624 |
| Domestic Indigent (eligible for free 50 kwh per month) | 80 | 39,292 | 491 | 471,501 |
| Domestic Non-Indigent | 11,681 | 10,432,118 | 893 | 125,185,413 |
| Municipal Houses | 17 | 9,926 | 593 | 119,114 |
| **Total** | **97,583** | **32,324,304** | **331** | **387,891,651** |

**BCM Domestic Prepaid:** BCM supplies to 97 583 account holders (see Table 15). Of these, 85,806 holders have prepaid accounts (in other words the users purchase electricity tokens to recharge their account). Prepaid account holders use on average 255 kwh per month, which represents the lowest level of consumption of the four categories of account holders supplied by BCM. Domestic prepaid account holders can generally be correlated with low to medium income households. Although these households typically have lower energy profiles, the reduced electricity consumption may also be attributable to mixed household fuel use, where, for example energy for lighting is derived from electricity, while paraffin is used for cooking.

**BCM Domestic Indigent:** Domestic Indigent accounts are metered accounts, but where the user is eligible for the 50kwh free basic national electricity allowance as a result of low income levels. There are only 80 metered account holders are indigent users, since the majority of households eligible for the indigent allowance have prepaid accounts. Domestic indigent account holders use on average 491 kwh per month.

**BCM Domestic Non-Indigent:** BCM supplies electricity to 11,681 non-indigent metered account holders. Non-indigent accounts are roughly correlated with medium to high income urban households, which rely almost exclusively on electricity as an energy source. However, these households typically have higher overall energy consumption profiles. This is reflected in an average monthly electricity consumption of 893 kwh.

**Municipal Houses:** In 2007 BCM was supplying electricity to 21 municipal domestic houses, although this dropped to 0 in 2008. Average consumption of municipal houses was 593 kwh per month.

**Table 16: Characteristics of domestic electricity supply: Eskom.**

| | Number of accounts within BCM Supplied by Eskom | Ave Monthly consumption per account holder within EL and KWT technical service area (kwh). | Total annual consumption within BCM boundaries (kwh). |
|---|---|---|---|
| Small Power Users | 1,424 | 1,192 | 20,368,896 |
| Prepaid Power Users | 36,006 | 71 | 30,599,339 |
| **Total** | **37,430** | | **50,968,235** |

**Eskom Small Power Users**

Eskom supply to households in rural areas is in the form of Small Power User Supply, and Prepaid User Supply. Small Power Users are metered users, often running smallholdings, general stores or living in small villages or coastal towns such as Sunshine on Sea. There are 1,424 Small Power User accounts within the boundaries of BCM. Average consumption is 1,192 kwh per month, and in total this group consumes 20,368,869 kwh per year. Eskom small power users consume more power than domestic users within urban areas. This may be attributable to the power requirements of smallholdings and general stores or small industries.

**Eskom Prepaid Power Users**

Eskom supplied Prepaid Users are typically villagers living in rural areas. There are 36,006 Prepaid Users, with an average power consumption of 71 kwh per month.

### 7.3.2 Paraffin

In BCM approximately 17,226,480 litres of paraffin is used annually. This is at a derived average consumption rate of 20 litres per paraffin consuming household per month (see section 4.4.2 for further information). Paraffin makes up 26% of the municipal household energy mix, but due to lower emissions per joule of energy used, paraffin is only responsible for 8% $CO_2$ emissions (namely 39, 653 tons of $CO_2$ emitted per year).

### 7.3.3 Fuelwood

Approximately 10,422,274 kg of fuelwood is burned for household use in BCM per year. Fuelwood makes up 8% of the household energy mix. It should be noted that fuelwood is considered a renewable energy source if grown and harvested sustainably. In terms of carbon emissions profile procedures, fuelwood is excluded from consideration in regard to global CO2 emissions and greenhouse gas impacts. In this State of Energy Report, it is assumed that fuelwood is harvested sustainably, and therefore has been allocated a score of zero for carbon emissions.

### 7.3.4 LPG, Coal and others.

An estimated 534,152 $m^3$ of LPG is sold for domestic purposes in BCM, which is responsible for less than 1% of the BCM household energy mix, and less than 1% of emissions. It is possible that a proportion of households are converting to LPG for cooking purposes as a response to the national energy crisis.

Approximately 475,800 kg of Coal is sold to the residential sector per year, which forms less than 1% of the BCM household energy mix, and is responsible for less than 1% emissions.

It is likely that higher income urban households are purchasing generators as back-up electricity supply. Although there are currently no records to show it, it is possible that petrol and even diesel may become noteworthy element of the higher income household energy mix.

## 7.4 Energy profile of rural households

Figure 26 shows that 87% of rural households have electrical supply, although a small percentage of these connections is illegal or indirect. 12.9% of households have no electricity.

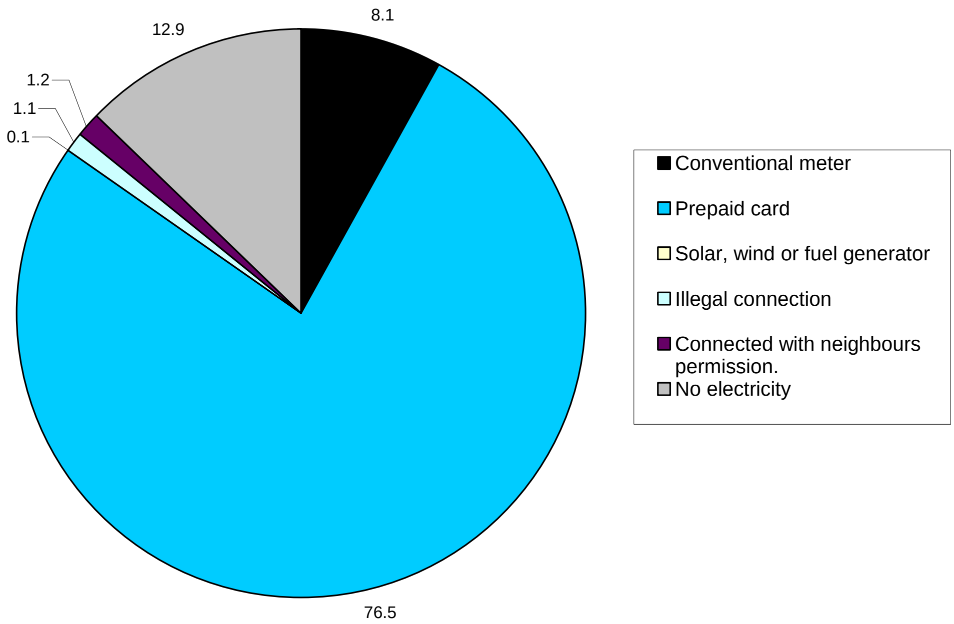



**Figure 26: Type of electrical supply in rural households of BCM (BCM Quality of Life Study, 2007)**

Despite the 87% level of electrical connections, only 65.2% of rural households use electricity of cooking. The remainder of energy sources for cooking include gas (1.8%), paraffin (29.6%) and wood (3.2%).

## 7.5 Energy profile of low income informal households.

The 2007 BCM quality of life study shows that 28.1% of urban informal households within BCM are conventionally electrified, while 59.1% of households have no electricity (Figure 27). Of concern is that 12.4% of households have unconventional electrical connections, including 6.1% illegal

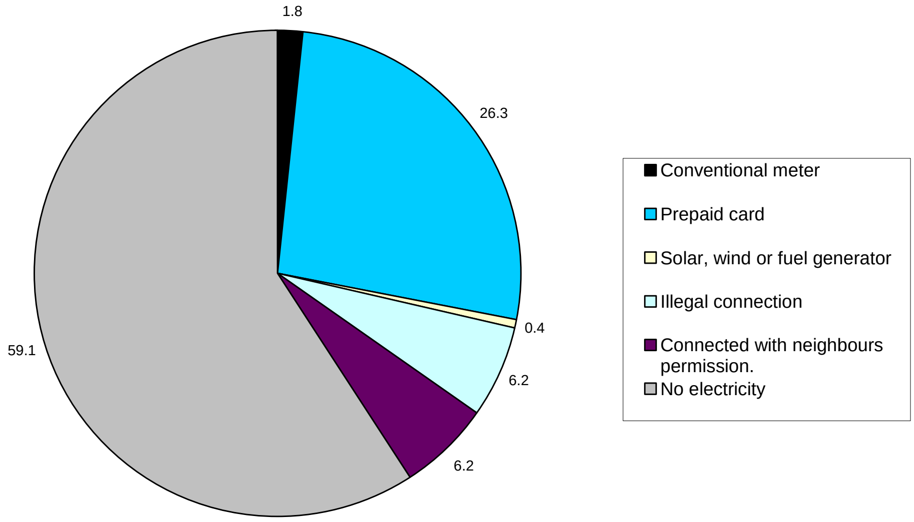



**Figure 27: Type of electrical supply in urban informal areas of BCM (BCM Quality of Life Study, 2007)**

Apart from the fact that illegal connections constitute theft from the municipality, they also represent serious sources of danger in terms of electrical shock and fire. In 2007, shack fire records show that 5 of 11 shack fires caused by electricity are likely to have been caused by illegal electrical connections (pers. comm. Owen Bekker). In addition,

Surveys conducted by BCM Disaster Management have found that although households may be connected to electricity, this source of energy is mostly used for appliances such as lighting, TV and radio. The more energy intensive uses such as cooking and heating tend to be based on paraffin and wood. This may be related to a common perception that paraffin is a cheaper form of heating than electricity. Alternatively, households that are newly electrified are initially unwilling or unable to make the initial financial outlay to procure electrical cooking and heating appliances. Furthermore, households tend to purchase second hand electrical equipment, which may also contribute to electrical shock and electrical fires.

Figure 27 shows that 59.1 percent of informal households have no connection to electricity. These households are generally reliant on wood and paraffin for energy requirements, and can be considered to make up the majority of paraffin consumption in BCM.

The 1999 Duncan Village Survey (Bekker, 2000), shows that 80% of shacks used paraffin lamps for lighting, 46% used paraffin primus stoves for cooking, and 44% used primus stoves for heating. In contrast, BCM Quality of Life Survey shows that 65.7% of urban informal households use paraffin for cooking.

However, paraffin as a source of energy for lighting, heating and cooking in informal settlements is also a significant source of danger, and a principal cause of shack fires. For example:

- Shacks dwellers may use primus stoves for heating, where corrugated iron is placed on top of the flame to radiate heat. The corrugated iron may become red hot and dangerous.

- Shacks are often cramped for space and children playing within the shacks may knock over primus stoves or paraffin lamps.
- Parents sometimes leave a meal cooking on a primus stove when away on an errand.

Woodfuel as a source of energy for cooking and heating would be expected to be used predominantly in rural areas. However, the 1999 Duncan Village Shack Survey shows that 43% of households use woodfuel for cooking and 44% for heating. Households often use *umbawula* (brazier), a 20 litre drum punched with holes, as the receptacle in which fires are made. The use of fire poses danger in terms of causing shack fires, as well as carbon monoxide poisoning when people bring the *umbawula* filled with coals into the shack for heating at night.

Other sources of energy in informal settlements include the use of candles for lighting, and batteries for lighting, TVs and Radios.

## 7.6 Energy profile of urban Formal households.

It is important to note that energy profiles of low income formal households differ from higher income formal households. This is borne out by the fact that 94.9% of households in formal areas are connected to electricity, but only 73.9 percent of households use electricity for cooking. Only 6.7% of the remaining households use gas, while 19.3% use paraffin.

Low income formal households can roughly be associated with prepaid electricity supply be BCM and more affluent households associated with metered electricity. The difference in energy consumption between prepaid and metered households on average in BCM is 255 kwh per month vs 893 kwh per month. In other words metered households draw roughly 3 times more electricity than prepaid households.

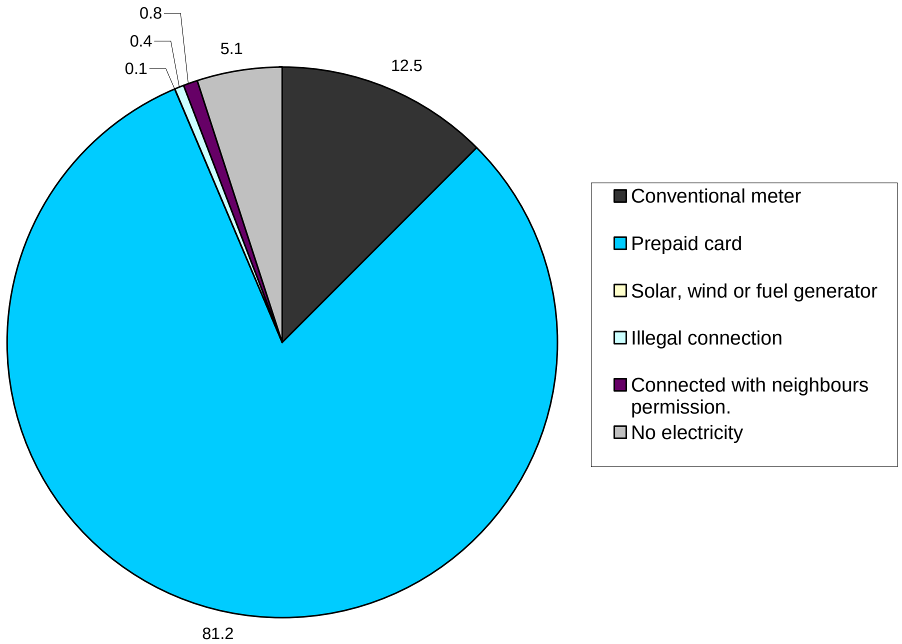



**Figure 28: Type of electrical supply in urban formal households in BCM (BCM Quality of Life Study, 2007)**

## 7.7 Key Issues

### 7.7.1 Opportunities

(a) Urban Informal:

- BCM together with the National Department of Housing is continually establishing new housing within BCM in an effort to reduce informal housing. As it stands, it would appear that the housing backlog in 2007 had reduced to approximately 60,000 from 75,000 in 2004. Associated with formal housing is formal electrical connection, which means that families previously living in informal housing can become independent from paraffin as a source of energy. In turn this will reduce the risks of fire, poisoning and shock due to illegal electrical connections.
- Education about ethanol stoves
- Education about energy cost of paraffin vs electricity
- Education about using second hand appliances and illegal connections.

(b) Urban Formal

Low Income:
Opportunities for improved energy efficiency in RDP housing:

- Mass rollout of solar water heaters
- Ceilings and insulation.
- CFLs
- Green design of new RDP housing.

Pilot study – Potsdam Sustainable Housing Project.

Higher Income:
Opportunities for improved efficiency:

- Solar water heaters (including Eskom subsidy)
- CFLs
- Improved energy awareness.
- Energy efficient appliances.
- Household renewable sources such as turbines and solar PV.

### 7.7.2 Constraints

(a) Urban Informal and low income formal:

- Low household income is a barrier to making sustainable energy choices.
- Perceptions that paraffin is a cheaper source of energy than electricity.
- Inability to afford new electrical appliances or maintain existing equipment.
- Problems with mass rollout of energy interventions in relation to the Municipal Finance Management Act.
- Mass rollout of solar water heater in low-income areas will have very good quality of life and energy saving results. However, commercially available solar water heaters are large and expensive. A locally manufactured, cheaper solution should be investigated.

(b) Urban higher income formal
(c) National energy crisis.

### 7.7.3 Social

- Energy poverty and inability to make sustainable energy choices.
- Poor access to sustainable energy is a major socio-economic constraint.
- Heavy reliance on paraffin and woodfuel causes household and local air quality issues.
- Disaster Management issues associated with paraffin, woodfuel and illegal connections in informal housing areas.
- Inequality of energy profiles.

### 7.7.4 Economic

- Expensive fuel types such as paraffin.
- Economic implications of installing solar water heaters and renewable sources of energy.

### 7.7.5 Environmental

- Social and economic preferability of electricity, vs. high emissions footprint per joule of electricity used as compared to other forms of energy such as gas and paraffin.
- The need to augment BCM electricity supply with renewable sources of electricity such as biogas, wind and solar generated electricity, in order to reduce the $CO_2$ footprint of electricity supply in BCM.
- Local air quality issues associated with using paraffin, vs global air quality and greenhouse issues associated with using electricity.
- High electricity consumption of urban households.

## 7.8 Existing Responses and Initiatives

### 7.8.1 National Policy and Legislative Responses

(a) Addressing Energy Poverty: Free Basic Energy

Free Basic Electricity was launched by the Department of Minerals and Energy in 2003 to assist indigent households in meeting their basic needs. Currently indigent households in BCM receive 50 kwh of free electricity per month. However, due to the limits of electricity grid connectivity, the government has also developed a Free Basic Alternative Energy Policy. This will apply to households that are not grid connected.

(b) National Response to South Africa’s Electricity Shortage (January 2008)

On the 25th of January 2008, the South African Government published a National Response to the Electricity Shortage. The response sets out a number of medium and long-term interventions to improve energy efficiency. Some of these measures apply to residential housing:

*Solar Water Heating Programme*

This programme aims to install 1 million solar water heaters over the next three years. To achieve this, it has instituted a subsidy of 20 to 30% on selected solar water heaters. The programme foresees a national electricity saving of 650 MW.

The programme is targeting both the households, group houses (e.g. army bases, mine residences) commercial and industrial applications.

*National Housing Specifications*

Water Heating (Pg 14):
*The Department of Housing is drafting legislation that will mandate that all new houses are to be fitted with solar water heaters with a back up electrical element that is fitted with a geyser load management switch, a time switch or an interlocker between a geyser and a stove. The interlocker will ensure that the geyser and the stove are never switch on simultaneously. Alternatively the water heater should be gas powered without any electrical backup.*

Building Standards (Pg 14):
*SABS will be tasked with the development of building standards and will ensure that these are applied nationally. The appropriate energy building standards will be specified for all new buildings as a priority, to include:*

- *Ceiling insulation*
- *Geyser insulation (including pipe insulation)*
- *Double glazing*
- *Weather stripping of doors and windows*

(c) Draft 2008 Regulations under the Electricity Regulation Act (2006)

The National Department of Minerals and Energy has published a draft set of regulations under the Electricity Regulation Act (2006), namely:

Electricity Regulations For The Prohibition of Certain Practices in the Electricity Supply and Compulsory Norms and Standards for Reticulation Services - Draft Regulations 2008

These regulations have implications for residential housing:

*In order to minimise electricity load shedding and blackouts, thereby improving the quality of supply, a licensee* (in the case of BCM, the Municipality) *must ensure that the following activities are prohibited in its licensed area of jurisdiction: -*

*(a) In respect of lighting:*

*(i) Proliferation of incandescent lights. Energy efficient substitutes must be used instead;*

*(b) In respect of water heating in commercial and residential buildings:*

*(i) Installation of an electric geyser that does not incorporate solar water heating facility to new dwelling with a value exceeding R750 000;*

*(ii) Notwithstanding subsection b(i), installation of electric geyser that does not incorporate solar water heating facility to new dwelling with square meters exceeding 300;*

*(iii) Any new geyser without an insulation blanket;*

*(c) In respect of water heating in commercial and residential buildings, to be in place not later than the year 2010:*

*(i) Installation of an electric geyser that does not incorporate solar water heating facility to office blocks, hospitals, hotels and resorts, and shopping complexes) feeding from centralised water heating systems;*

(ii) A water heating geyser without a facility for the licensee to remotely control its supply of electricity;

(d) In respect of space heating, ventilation and cooling in commercial and residential buildings, not later than the year 2010:

(i) A heating, ventilation and cooling system that does not incorporate a facility for the licensee to remotely control its supply of electricity;

(e) A swimming pool drive and heating system without facility for the licensee to remotely control its supply of electricity.

*Norms and standards for reticulation services:*
*(c) End user or customer with monthly consumption of 500kWh and above must be on time of use tariff not later than 2010.*

(d) National Building Regulations

The National Housing Programme has published revised building regulations, namely:

Revised Technical Norms and Standards for The Construction of Stand Alone Residential Dwellings Financed Through the National Housing Programmes.

The standards came into effect in April 2007.

The standards include guidelines for thermal efficiency (Pg 12):

*Designs for affordable housing must take cognisance of the need for the resultant dwellings to be thermally efficient. The cost constraints imposed by the subsidy scheme make it difficult to meet this requirement. However, there are several principles that, if followed, will enhance the thermal efficiency of the dwelling at minimal cost. These are:*

- *The longer axis of the dwelling should be orientated so that it runs as near east/west as possible.*
- *The dwelling should be compact in plan with the rooms that are used most and the major areas of glazing placed on the northern side of the building to allow solar heat to penetrate the glazing during the winter months.*
- *The roof overhang to the northern wall should be sufficient to shade the windows from midday summer sunshine.*
- *Windows facing east and west should be limited in number and confined in area to the minimum required for daylight and ventilation.*

### 7.8.2 National Initiatives

The Green Building Council of South Africa was established in May 2007 at the initiative of the CSIR. The council focuses mostly on commercial, industrial and public buildings, but should also have an influence on domestic buildings.

### 7.8.3 Local Responses

(a) Coastal Condensation Fund:

BCM has recently been included into the Department of Housing Coastal Condensation Fund. This fund represents a top up of R7,000.00 to the existing cost of constructing an RDP house (namely R43,000), in order to install ceilings and add plastering to walls.

(b) Potsdam Housing Project:

BCM together with the Department of Science and Technology is in the process of developing a pilot housing low cost housing estate at Potsdam (Mdantsane Unit P Housing Estate), which will incorporate energy efficiency features. The following features are recommended by the Centre for Scientific and Industrial Research:

- North facing orientation of units
- Reduced road width, and the use of roads as stormwater drainage channels, together with reduced use of stormwater pipes.
- Community scale wind generators as a supplementary source of electricity
- Installation of solar water heaters
- Installation of rainwater tanks to reduce reliance on municipal water.

(c) BCM Electricity Demand Side Management

BCM has been given a mandate by Eskom to reduce electricity consumption by 10%. BCM has thus far implemented demand side management measures in the residential sector such as installing ripple control switches in household geysers. BCM intends to extend demand side management measures in the industrial sector, and have appointed service providers to facilitate this.

# 8 LOCAL AUTHORITY

## 8.1 Introduction

This chapter examines the energy profile of the Local Authority Sector, that being the Buffalo City Municipality.

## 8.2 Sector Energy Profile in BCM

Buffalo City Municipality is one of eight local (Category B) municipalities that fall within the jurisdiction of the Amathole District Municipality. BCM is the economic hub of the ADM and the eastern region of the Eastern Cape Province and as such carries an almost “Metropolitan” status as it functions independently with little support from the district level.

The BCM has jurisdiction over a large area, is a major building and property owner, has a substantial staff compliment and has a large vehicle fleet, is responsible for future planning and thus has a leading role to play in terms of conserving energy in terms of its functions and operations.

### 8.2.1 Core Functions

Buffalo City Municipality provides a wide range of services to communities, either on its own, in conjunction with other spheres of government or in association with other organisations, including business and non-governmental organisations. Buffalo City provides a wide range of services, including:

- Electricity Distribution and management of electricity infrastructure;
- Water distribution;
- Sewerage Management;
- Refuse Collection
- Waste Disposal;
- Property Management;
- Road Development and Maintenance;
- Traffic Management including traffic lights and signage
- Primary health care;
- Certain aspects of housing provision;
- Public space management including public lighting, parks and other facilities
- Library services;
- Sports and recreational facilities;
- Facilities for the elderly;
- Environmental management and environmental health services; and
- Information services.

All of the above mentioned services provided by the local authority have direct and indirect impacts on energy use via planning, private and public service delivery, and housing delivery. Indirect impacts are addressed in other chapters of this report.

Buffalo City has an annually reviewed Integrated Development Plan which provides a short-term strategy and detailed actions and projects in order to achieve a sustainable city.

The BCM has recently completed a City Development Strategy, which provides a 20 year vision for the municipality.

The focus of this chapter is on the local authority as an energy user. The main activities that use energy within the functions of the local authority are:

- Vehicle fleet operation;
- Local authority buildings;
- Streetlights and traffic lights;
- Waste water treatment, Bulk water supply, and
- Solid waste management.

### 8.2.2 Municipal Departments and their association with energy

The following section describes those municipal departments that have an integral role in energy planning and development.

(a) City Planning

Buffalo City has a well established planning department that is divided into forward planning and settlement planning. Both divisions have in integral role in energy planning albeit an indirect one.

Some key interventions undertaken by the City Planning Department that have important implications for energy management include:

- The BCM Spatial Development Framework is the overarching tool used to guide future planning in the city. The SDF defines an urban edge to control urban expansion, which ultimately controls transport movements. Most of the city planning is focused on developing around existing transport nodes such as, for example, railway stations. Traffic Management Plans are an integral component of all SDF reviews.
- The City has embarked on a densification strategy to ultimately reduce transport distances from home to the work place. This includes changing policy initiatives such as reducing the minimum erf size to create a denser residential settlement pattern, allowing compatible low intensity businesses within residential areas etc.
- City planning has identified various Provisional Restructuring Zones, which have the objective of bringing the poor closer to places of employment.
- City Planning has embarked on various re-generation areas in the city (e.g. Quigney, Beach Road etc.), which aim to make areas central to the city attractive for development.

(b) Electricity Department

The BCM Electricity Department manages the majority electrical supply to commercial, industrial and residential customers within the BCM urban edge as defined in the Spatial Development Framework. The department also manages streetlights and the maintenance of all municipal electrical infrastructure.

(c) BCM Integrated Environmental Management Department

Buffalo City Municipality have an active Integrated Environmental Management Planning Department that are responsible for the protection and management of the natural environment in Buffalo City. The BCM IEMP unit has a council accepted Integrated environmental Management Plan which recognised the need for this project as a tool to achieve the sustainable use of energy, both renewable and non-renewable.

(d) BCM Transportation Planning Department

The Buffalo City Transportation Planning Department is responsible for traffic management (including pedestrian, public & private transport), future traffic planning and the management of traffic lights. Much of the planning work undertaken by the Transportation Planning Department has energy planning associations. Their forward planning is described in their Integrated Transport Plan.

(e) BCM Environmental Health

Buffalo City Environmental Health is responsible for promoting a healthy environment for all its residents. The department is in the process of developing an Air Quality Management Plan to which emissions released by the burning of fuels is an important component.

(f) BCM Disaster Management

The BCM Disaster Management Department primary function is to mitigate the occurrence of disasters such as those caused by fires, floods, accidents etc. Many fires, particularly in informal settlements are caused by burning fuels and wood in the informal settlements for energy for heating, cooking and lighting. The BCM Disaster Management Department therefore has an important role to promote the use of clean and safe fuels in such areas.

### 8.2.3 BCM Vehicle Fleet

The Buffalo City Municipality has a substantial vehicle fleet amounting to a total of 889 registered vehicles. The average year model of the fleet is 1999. During the 2006/07 financial year, 17 new vehicle purchases were made. All vehicles were rated by the BCM Mechanical Engineering Department according to their condition. Only 48% of the vehicle fleet is considered to be either “new” or in “good” condition (Figure 29). This has relevance in terms of energy consumption as it is likely that newer vehicles and those in good condition are likely to be more energy efficient.

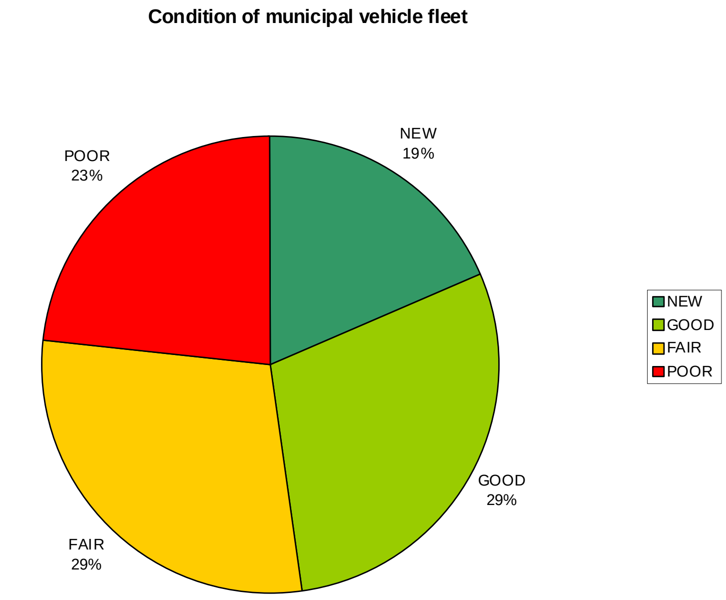



**Figure 29: Condition of municipal vehicle fleet.**

In terms of fuel type, there is almost a 50:50 split in terms of petrol and diesel vehicles within the municipal fleet Figure 30.

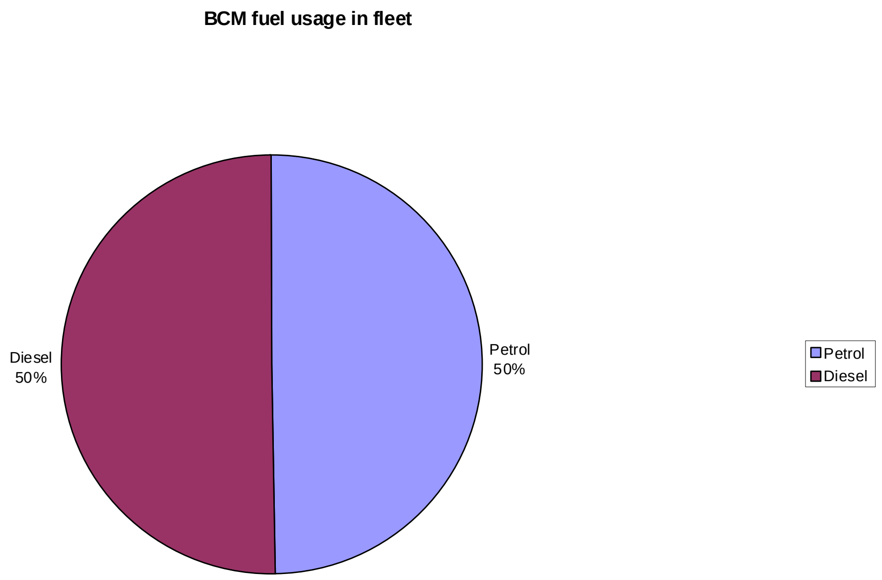



**Figure 30: Fuel type usage within the municipal fleet.**

No direct fuel quantities were recorded for the BCM fleet as a whole. However during the period July 2007 to April 2008 the municipality spent R6 297 960.98 on petrol and R9 105 432.34 on diesel. Using an average price of R8.67 and R9.38 for petrol and diesel respectively the consumption of petrol and diesel by the BCM can be extrapolated as follows:

**Table 17: Annual fuel quantities utilised by BCM vehicle fleet**

| Fuel Type | Petrol | Diesel |
|---|---|---|
| Quantities in litres per year[7] | 870 859 | 1 164 874 |

### 8.2.4 Local Authority Buildings

BCM has a host of municipal buildings scattered throughout the municipality. Major administrative buildings include:

- Trust Bank Building – Oxford Street East London
- Engineering and Planning Department Building - Oxford Street East London
- Queenspark Zoo
- Health Department

At present very few of the buildings have been equipped with energy efficient implementation measures and there has been too date no strategy or policy to minimise energy use. This poses a significant opportunity.

### 8.2.5 Streetlights and traffic lights

Traffic lights are controlled by the Transport Planning Department. In 2005, electricity consumption by traffic lights amounted to 69 073 kwh per month (pre LED replacement). A role out strategy has been implemented to replace all traffic lights with energy efficient LED bulbs. Although initial costs are considerably higher, long term electricity savings are achieved. Approximately 50% of all traffic lights within BCM have been replaced. Additional funding is required to complete the installation process.

Streetlights are managed by the electricity department. In 2004 it was estimated that there were between 35 – 38 000 streetlights in BCM. During this time the electricity consumption was 1003515 kwh per month. Most of the streetlights are fitted with 125W mercury vapour bulbs but the municipality is in the process of replacing with 70W high pressure sodium bulbs.

The esplanade area along East London's main beachfront has had new street lights installed which have energy efficient bulbs.

### 8.2.6 Waste Water Treatment and Water Delivery

The pumping and supply of potable water as well as the treatment of effluent are highly energy intensive activities. The waste water department noted that their biggest expenses in terms of waste water treatment is chlorine and electricity. Expenditure for electricity from the treatment works themselves and pumping costs amounted to approximately R14M for the 2007 financial year which equates to   kwh per year at a rate of 40c per kwh.

According to the BCM state of sanitation report, the city is treating in the order of 110ML/day of sewage with works with a design capacity of 145ML/day (Table 18).

[7] Based on an average price of R8.67 per litre for Petrol and R9.38 for diesel for 2007.

A number of initiatives have been implemented in terms of energy savings:

- The Gonubie WWTW is in the process of being upgraded with new technology in terms of the treatment process (air blowers as opposed to surface aerators) and is in the order of 75% more efficient in terms of electricity. The works is being upgraded from a 6ML/day works to an 18ML/day works.

Various organisations have approached the sanitation department with the possibility of extracting methane for electricity generation at some of the WWTW either directly from digesters or sludge. In the light of this opportunity, the sanitation department will call for proposals via a tender process and evaluate potential possibilities.

**Table 18: Description and status of BCM operated WWTW (SoSanitation Report, 2007).**

| Treatment Works (Year) | Design Capacity (ML/Day) | Current Flow (ML/Day) | Owner / Operator | Comments |
|---|---|---|---|---|
| Berlin (1972) | 2 | 0 | BCM | Township flows |
| Bisho Ponds | 1 | > 3 | BCM | Severely overloaded |
| Breidbach Ponds (?) | 1 | > 2 | BCM | Severely overloaded |
| Central (Amalinda) (1972 and 1997) | 5 | 5 | BCM | Severely overloaded |
| Christmas Rock (?) | 0.1 | Unknown | ? | |
| Dimbaza (1986) | 7 | 6 | BCM | Nearly at capacity |
| East Bank (1985) | 40 | 35 | BCM | Second reactor needed clarifiers for ELIDZ; sludge handling |
| Gonubie (1975) | 6 | 8 | BCM | Requires upgrading and sludge handling |
| Kaysers Beach (Ponds) | 0.2 | Unknown | ? | |
| Kidds Beach (Ponds) | 0.2 | Unknown | ? | |
| King William's Town | 4.8 | 5.2 | BCM | Overloaded |
| Macleantown (Ponds/irrigation | ? | ? | ? | |
| Mdantsane East (1972 and 1976) | 18 | 20 | BCM | Overloaded |
| Mdantsane West (Potsdam) (1984) | 9 | 7 | BCM | With unit volume the works will reach capacity |
| Reeston | 2 | 0 | BCM | For new houses the works must be expanded |

| Treatment Works (Year) | Design Capacity (ML/Day) | Current Flow (ML/Day) | Owner / Operator | Comments |
|---|---|---|---|---|
| Schornville (1971and 1982) | 5 | 5 | BCM | Severely overloaded |
| West Bank (Headworks, 2002) | 40 | 8 | BCM | New marine outfall, Illegal and requires pipeline |
| Zwelitsha (1975 and 1982) | 9 | 6 | BCM | Marginal |

### 8.2.7 Solid Waste

The BCM provides a solid waste collection service to all urban areas within BCM. Approximately 350 000 tons of solid waste are produced in the BCM area per year. Major energy expenditure is experienced in terms of collection, clearing of illegal dumping, street cleansing and waste disposal (the waste department currently operates 25 tipper and flat bed trucks, 35 compaction units, 1 skip loader and 3 load luggers).

Very little formal recycling is practised or encouraged by the municipality although it has been recognised as a future integral component of the city's waste management system. Recycling can be viewed as an important energy saving initiative as it reduces the quantities of waste handled and disposed of which ultimately reduces the energy requirements of transportation and disposal.

The department currently manages a number of disposal sites. These are tabulated as follows:

**Table 19: Description and status of landfill sites within the BCM area.**

| Name | Type of facility | Location | Status |
|---|---|---|---|
| Buffalo City Regional Waste Disposal Site | Permitted for General Waste (Large) | Berlin | Operational, receiving waste from Mdantsane and Berlin. Will serve as the regional site for the BCM area in the near future. |
| King Williams Town | Permitted for General Waste (Medium) | King Williams Town | Operational. Has approximately 10 years of available airspace. |
| Second Creek | Unpermitted, Large dump site. | East London | Due for closure. |
| Gonubie Garden Waste Site (Riegers) | Garden Waste and Builders Rubble | Gonubie | Operational. Privately managed. |
| NU2 | Unpermitted, Medium size dump site. | Mdantsane | Closed and due for rehabilitation. |
| Ducats | Unpermitted, Large dump site. | Ducats, peripheral East London | Closed and rehabilitated. |

Like the sanitation department, various organisations have approached the solid waste department with the possibility of extracting methane at some of the landfill sites for electricity generation.

## 8.3 Key Issues

The following opportunities are noteworthy:

- Driver training is an opportunity to influence fuel usage (e.g. prevent excessive idling of vehicles, responsible driving techniques etc.).
- A significant energy saving can be achieved by installing energy efficient lighting in the municipal buildings.
- Methane extraction at some the city's WWTW presents a possible energy source.
- Landfill gas extraction at some of the city's landfill sites presents a possible energy source.

Constraints

- There is no monitoring (vehicle tracking system) or interrogation of the municipal fleet. This could lead to abuse of municipal vehicles, theft of fuels, and inefficiency in terms of operations.
- The option to introduce an alternative fuel source (e.g. gas) into the municipal fleet is limited by the lack of refuelling opportunities/ locations.
- Deficiencies in road infrastructure, lack of facilities for pedestrians and cyclists all impact on energy consumption.
- Fragmented settlement planning throughout BCM has obvious consequences for sustainability, requiring a more extensive and expensive transportation network and public transport system.
- The rail network and associated operations is not a municipal function.
- The Municipal Finance Management Act means that projects cannot be financially ring-fenced. This means that there is no direct incentive brought about by the financial savings associated with energy savings.
- The possibility of BCM electricity distribution being subsumed into a regional electricity distributor is undermining current energy planning.

## 8.4 Existing Responses and Initiatives

High energy inefficiency is experienced in congested traffic with standing vehicles. The City is implementing a roundabout strategy to release congestion and reduce travel speeds.

To combat load shedding and its effect on traffic congestion, BCM is in the process of purchasing UPS technology for traffic lights at key intersections, particularly near schools where morning congestion is high.

A retrofitting streetlight strategy with energy efficient bulbs is in the process of implementation.

The Electricity department has planned to undertake an audit of all municipal buildings with a view to implementing energy efficiency.

BCM are about to implement a fuel tracking system in all of its vehicles. This will assist in controlling usage and will ultimately assist in controlling theft and wastage.

The Mdantsane Water Loss Management Programme should reduce treated water requirements of BCM. This will save excessive pumping and treatment costs incurred by BCM.

Efficient Sewage Treatment Works. The city is exploring more energy efficient methods of sewage treatment.

Ripple Control:
BCM Electricity has installed ripple control units in East London. This has saved 12 MW of peak electricity requirements. Ripple control switches will in future be installed in Mdantsane and King Williamstown as a second stage of Demand Side Management. As a third phase, ripple control switches may be installed for geysers and air conditioners of industrial and commercial consumers. However, the possibility of interfering with industrial processes will have to be avoided.

BCM is currently drafting an Electricity Master Plan with a 5, 10 and 20 year outlook The master plan will have energy efficiency considerations.

By-laws:
BCM is currently in the process of reviewing by-laws. Energy savings will be worked into these by-laws (Pers Comm Rob Ferrier).

# 9 COMMERCE AND INDUSTRY

## 9.1 Introduction

This chapter examines the energy profile of the Commerce and Industry Sector that falls within the Buffalo City Municipal region.

## 9.2 Sector Energy Profile within South Africa and Eastern Cape

Nationally the sector can account for up to 60% of the South African energy consumption. Mining activities are responsible for a substantial component of the national energy consumption profile. There is not much mining activity in the Eastern Cape and as such the energy consumption profile for this sector does not mirror the national picture.

The low price of coal and electricity in South Africa has contributed to the development of an economy with a large energy-intensive primary industrial sector. This has had substantial negative environmental impacts and it is only recently that policy has identified the need for implementation of energy efficiency in this sector.

## 9.3 Sector Energy Profile in BCM

Buffalo City is one of the key economic hubs of the Eastern Cape Province and is the most important economy in the eastern part of the region. In 2004, it was estimated that Buffalo city contributed 23% to the total GDP of the province and provided 19% of the province's formal employment opportunities.

The economy, like other South African economies, has shown a gradual shift from the primary and secondary sectors to significant growth in the tertiary sector. However in comparison to other cities in South Africa, Buffalo City's economy was the third worst out of the nine cities assessed (BCM IDP 2008/09).

This sectoral split is tabled below:

**Table 20 : Performance of the Primary, Secondary & Tertiary Sub-sectors, constant 2000 rands (BCM, IDP 2008/09).**

| Sub-sector | GDP (2004) | % of GDP | % of Sector | % Sector & sub sector of BCM economy |
|---|---|---|---|---|
| Primary Sector | | | | 0.9 |
| Agriculture | 175 295 584 | <1% | 90.5 | |
| Mining | 18 363 832 | <1% | 9.5 | |
| Secondary Sector | | | | 23.5 |
| Manufacturing | 4 629 664 798 | 20% | 87.0 | |
| Electricity and Water | 289 581 582 | 1.2% | 5.4 | |
| Construction | 404 100 804 | 1.8% | 7.6 | |
| Tertiary Sector | | | | 75.6 |
| Trade | 3 719 453 659 | 16.4% | 21.7 | |

| Sub-sector | GDP (2004) | % of GDP | % of Sector | % Sector & sub sector of BCM economy |
|---|---|---|---|---|
| Transport and Communication | 1 741 393 325 | 7.7% | 10.2 | |
| Finance and business services | 5 311 790 095 | 23.4% | 31.0 | |
| Community, social and other personal services | 2 296 951 318 | 10.1% | 13.4 | |
| General Government services | 4 070 443 573 | 17.9% | 23.7 | |

East London's Commercial and Industrial Sector energy profile is largely influenced by its large industrial tenants. For this reason the energy consumption patterns of the large industrial tenants have been investigated and are described below.

### 9.3.1 East London Industrial Development Zone

The East London IDZ has been developed to attract new investment in export-driven industries. Although in its development infancy, with fourteen established tenants, but many planned in the near future, the ELIDZ will likely be a significant consumer of energy for Buffalo City Municipality.

Existing tenants currently rely on electricity as their principle means of energy but the IDZ corporation is looking at ways of encouraging energy efficiency into future development and investment. This includes the following:

- Renewable energy;
- Carbon Trading;
- Sustainable building design;
- Sustainable use of industrial water;
- An industrial waste management plan to minimise waste to landfill; and
- Development of a biofuels cluster

Current energy consumption is recorded in Table 21 below.

**Table 21: Annual energy consumption in the East London IDZ**

| Energy Source | Electricity | LPG | Diesel | LRP | ULP | |
|---|---|---|---|---|---|---|
| Quantity | Awaiting info | Awaiting info | Awaiting info | Awaiting info | Awaiting info | Awaiting info |

### 9.3.2 Mercedes Benz South Africa (MBSA) and Associated Industries

The industrial economy of East London is largely focused around its main anchor motor industry, Mercedes Benz South Africa (formerly known as Daimler Chrysler SA) and associated support industries. In terms of energy consumption, MBSA relies heavily on both electricity and LPG as sources of energy. The total electricity consumption for the 2007 period was 72 125 754 kwh where a total of 31955 vehicle units were produced (Table 22). In 1997 the total electricity consumption was 32 047 000 kwh where a total of 29348 units were produced which is an indication that electricity consumption per vehicle unit has nearly increased two-fold.

**Table 22: Annual energy consumption for MBSA (2007 figures)**

| Energy Source | Electricity | LPG | Diesel | LRP | ULP | Green Power |
|---|---|---|---|---|---|---|
| Quantity | 72 125 754 kwh | 3 360 239 kg | 169 830 litres | - | 504 622 litres | 617 714 kwh |

MBSA purchases Amatola Green Power (AGP). In 2007 617 714 kwh was supplied to MBSA via the ESKOM transmission network from AGP, the source coming from sugarcane/ bagasse cogeneration in KwaZulu Natal (pers. comm. Van Niekerk, ESKOM). Purchasing green power has the following advantages for MBSA:

- Marketing edge, using the Green image to promote products.
- Satisfying consumer demands for products that are environmentally friendly.
- Increased exports to countries where the Green Lobby is strong.
- Increased sales as new markets are developed.
- Assisting in ISO14001 accreditation.
- Displaying environmental policy in action.
- Enhancing current environmental profile or public image.
- Price competitiveness compared to other energy sources over the contract period.

MBSA uses large quantities of various gases of which LPG is by far the largest quantities utilised. In addition to LPG, MBSA utilised Nitrogen (2 424 kg), Oxygen, R134a Refrigerant (21 300kg), Acetylene (218 kg), Argon (5 376 kg) and Argoshield (4 241 kg) during 2007.

### 9.3.3 Johnson & Johnson

Johnson & Johnson is an international organisation specialising in pharmaceuticals and the production of health care products. A large production plant is located in Wilsonia, East London. In terms of energy consumption, they currently rely heavily on electricity and HFO with minimal usage of LPG and other fuels. Of interest is that J&J consumption for electricity and water has decreased by 23 and 32 % respectively over the last five-year period despite a doubling in the production capacity. The use of HFO has increased slightly from 35981lites in 2003 to 414014 in 2007.

**Table 23: Annual energy consumption for Johnson & Johnson (2007 consumption)**

| Energy Source | Electricity | LPG | Diesel | LRP | ULP | HFO |
|---|---|---|---|---|---|---|
| Quantity | 6758730 kwh | Minimal | No quantities recorded | No quantities recorded | No quantities recorded | 414014 litres |

### 9.3.4 Nestle

Nestle is an international organisation specialising in the production of food items. Nestle has a large production plant producing confectionary items located in central East London.

**Table 24: Annual energy consumption for Johnson & Johnson (2007 consumption)**

| Energy Source | Electricity | LPG | Diesel | LRP | ULP | HFO |
|---|---|---|---|---|---|---|

| | | | | | | |
|---|---|---|---|---|---|---|
| Quantity | Awaiting info | Awaiting info | Awaiting info | Awaiting info | Awaiting info | Awaiting info |

### 9.3.5 Castellano Beltrame

Castellano Beltrame is located in the West Bank industrial area and produces decorative trimmings, with products ranging from tiebacks, tassels, cords, braids, borders and fringing to imported fabrics. They rely on municipal electricity as their primary energy source (Table 25).

**Table 25: Annual energy consumption for Castellano Beltrame (2007 consumption)**

| Energy Source | Electricity | LPG | Diesel | LRP | ULP | HFO |
|---|---|---|---|---|---|---|
| Quantity | 4700484 kwh | - | - | - | - | - |

## 9.4 Key Issues

The following opportunities are noteworthy:

- The attraction of East London for investment lies in its low input costs and its excellent infrastructure, including an airport and a port. It is also well connected to the rest of the country by rail and road.
- The East London IDZ has invested capital towards research in renewable energy and energy efficiency.
- Various private organisations are interested in investing in renewable energy (wind power, landfill gas methane extraction etc.).
- Due to a strong international lobby, global industries are becoming increasingly aware of the damaging effect that the use of energy from fossil fuels and emissions have on our environment.
- Amatola Green Power supplies green energy to MBSA. Similar opportunities are available to other organisations.
- Carbon Credits are untapped opportunity.
- The electricity crisis and high crude oil prices has forced organisations to consider more efficient and reliable energy sources.

Constraints

- Electricity has traditionally been a cheap energy source to existing businesses and industry. As such businesses have well established systems that are reliant on electricity and change to other sources may be costly.
- In response to the electricity crisis and the unreliable supply, many businesses have purchased generators which utilise petrol and diesel. While this reduces the load on the national grid, they are not considered efficient forms of energy and contribute to air pollution impacts.
- Green power is slightly more expensive as opposed to fossil fuel generated electricity.

- To date there has been no education or awareness drive to encourage businesses to consider more efficient forms of energy.
- There is no policy or incentives to encourage the sector to consider more efficient forms of energy consumption in terms of production

## 9.5 Existing Responses and Initiatives

- MBSA utilises Amatola Green Power as a renewable energy source
- The East London Industrial Development Zone has established a biofuels cluster, and is promoting the development of a Biodiesel refinery that will rely on Canola as its chief source material.

# 10 RENEWABLE ENERGY, ENERGY EFFICIENCY AND CARBON TRADING

## 10.1 Renewable Energy

Renewable energy sources in South Africa include solar (photo-voltaic and thermal), wind, biomass and landfill gas. The South African White Paper on Renewable Energy defines renewable energy as follows (DME 2002):

*Renewable energy harnesses naturally occurring non-depletable sources of energy, such as solar, wind, biomass, hydro, tidal, wave, ocean current and geothermal, to produce electricity, gaseous and liquid fuels, heat or a combination of these energy types.*

**Solar energy** can be used to generate electricity; heat water; and to heat, cool and light buildings. For example, photovoltaic systems capture the energy in sunlight and convert it directly into electricity. Alternatively, solar thermal electric systems allow sunlight to be collected and focused with mirrors to create a high intensity heat source that can be used to generate electricity by means of a steam turbine or heat engine. It is anticipated that Solar Thermal Electric Systems will play a larger role than Photovoltaic systems in the medium term in South Africa (Banks and Schaffler, 2006).

**Wind energy** uses the naturally occurring energy of the wind either directly as in windmills or to generate electricity, and can be used, for example, to charge batteries or pump water. Large modern wind turbines operate together in 'wind farms' to produce electricity for utilities. Small turbines are used to meet localised energy needs. It is estimated that South Africa has 66 to 80 million MWh of potential wind turbine energy, particularly along the coastline (Banks and Schaffler, 2006).

**Biomass energy** (from organic matter) can be used to provide heat, make liquid fuels, gas and to generate electricity. Wood is the largest source of biomass energy, generally derived from trees. However, fuel wood is used unsustainably when new trees are not planted to replace ones that are used. Fuel wood derived in this way cannot be defined as renewable. Other types of biomass include plants, residues from agriculture or forestry, and organic components in municipal and industrial wastes. Landfill gas (biogas) is considered to be a biomass source.

**Bio-fuels** in liquid form can be produced from the conversion of biomass and used, for example, for transportation. The two most common bio-fuels are ethanol and bio-diesel. Fermenting any biomass that is rich in carbohydrate, such as maize, makes ethanol. Biodiesel is made using vegetable oils, animal fats and algae.

**Hydropower** uses the movement of water under gravitational force to drive turbines to generate electricity. Although there is the potential for increasing hydro power generation in South Africa, this is limited by the fact that South Africa is essentially a Water Scarce Country.

**Wave power, tidal power and ocean currents** can be used to drive turbines to generate electricity. Technologies to harness these forms of power are presently being developed to the stage of commercialisation. Currently, a Scottish company, Pelamis Wave Power, is in talks with the DME regarding the establishment of pilot plant off Mossel Bay.

**Geothermal activity** in the earth's crust derives from the hot core of the earth.

### 10.1.1 Renewable Energy: International Context

Renewable energy is increasingly recognised as an important form of energy in that it is generally associated with zero emissions of greenhouse gasses, while at the same time remaining independent from finite fuel types. This has been especially the case since the 1997 Kyoto protocol, which established binding emissions targets for participating developed countries. For example the European Union has a target of an 8 percent reduction in emissions relative to 1990 emissions levels. It follows that governments and industry, especially in developed countries, have significant incentives to convert from fossil fuel-based sources of energy, to renewable sources of energy.

Renewable energy generation is increasing at an unprecedented rate. For example installed global wind energy capacity increased from 59,091 megawatts in 2005 to 74,223 megawatts in 2006, and to 94,123 megawatts in 2007 (GWEC 2008). This means that the installation of wind power is increasing at a faster and faster rate from year to year. Currently the greatest acceleration in installations is taking place in North America and Asia (particularly India and China).

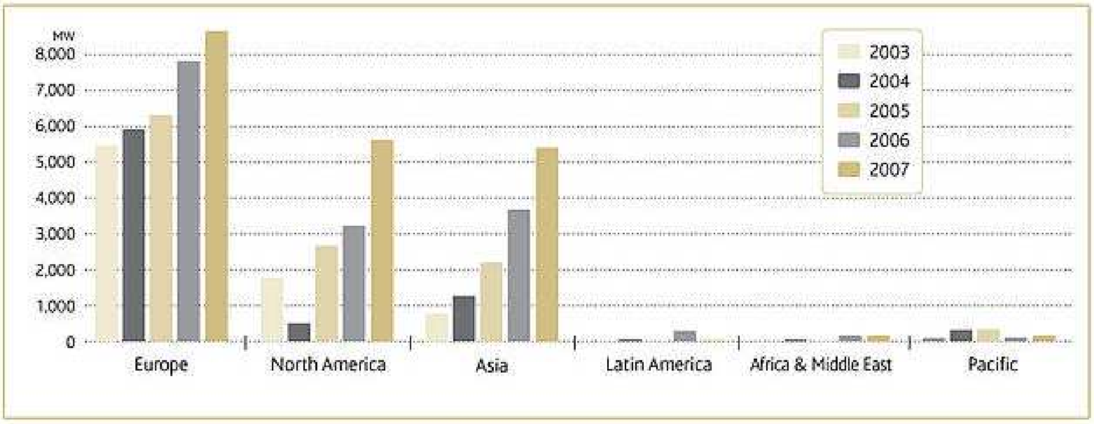



**Figure 31: Annual increases in installed capacity for wind generation (2003 to 2007). Source: Global Wind Energy Council, 2008**

The increased use of renewable energy is generally attributable to three factors, namely (Austin and Hanson, 2002):

- Technological improvements in the renewable energy sources;
- Rapidly changing energy markets; and
- Increased corporate awareness and concern about environmental issues.

(a) Improved Technology

Improvements in technology have facilitated significant reductions in the per-kilowatt cost of renewable energy. For example:

- Wind power is now 80% less expensive than it was 20 years ago. In Europe and the US, wind power can be generated at costs that are comparable with that generated by traditional utilities. Figure 31 shows the direct correlation between reduced cost of wind generated power, and cumulative installed capacity up to

2001, while Figure 32 illustrates comparative cost-curve scenarios for South Africa.

- The average price for solar photovoltaic cells has declined by over 80% over the last 25 years.

These cost reductions have allowed the major expansion in the installed capacity of renewable energy sources, while providing opportunities for the achievement of economies of scale, and initiating new cycles of learning and development.

(b) Changing Energy Markets

As non-renewable energy sources become more scarce, the world is experiencing dramatic changes in the energy market. World energy prices are increasing at an unprecedented rate, illustrated by the fact that crude oil has recently traded at historically high prices. At the same time corporate buyers of energy place ever-greater premiums on the reliability of energy supply. These factors underlie a continuously improving business case for the purchase of renewable sources of energy, or the integration of renewable energy with traditional energy sources.

(c) Increasing Environmental Concern

Changing trends in corporate governance and market preference in regard to sustainability mean that organisations are becoming increasingly sensitive to environmental developments. Furthermore, public concern about climate change and other environmental issues means that energy regulators will place more stringent conditions on the generation of energy. Therefore organisations are placed under ever increasing pressure to source energy with low emission profiles.

### 10.1.2 Renewable Energy in South Africa

South Africa has experienced, and is experiencing major economic growth (4.9% in 2005). The demand for electricity is effectively outstripping the ability the South African Utility, ESKOM, to supply electricity, both in terms of generation and transmission. This has stimulated ESKOM to place major emphasis on demand side electricity management, where electricity users are encouraged to improve their energy efficiency and to install alternative sources of energy. (co-generation)

(a) The Changing Costs of Renewable Energy in South Africa

Table 26 gives a cost comparison of current potential renewable energy costs as compared to the national utility price (Eskom). It can be seen that in certain cases renewable energy sources may be cheaper than Eskom prices. The cheapest and most easily installed renewable energy alternatives are solar thermal heating, electricity generated from landfill gas and heating and co-generation from biomass (such as bagasse). Electricity generation from wind-power also represents a viable and easily installable alternative, with costs comparable to Eskom rates.

**Table 26: Comparative current Renewable Energy costs in South Africa (Source: Banks and Schaffler, 2006).**

| Source | Cost (R/KWh) | Notes |
|---|---|---|
| Eskom Conventional Supply | 0.22 to 0.27 | Including 14.2% December 2007 increase. |
| Solar Photovoltaic | 1.50 | |
| Solar Thermal Electric | 0.40 | |
| Solar Thermal for Heating (residential) | 0.33 to 0.41 | |
| Solar Thermal for Heating (large-scale commercial) | 0.17 | |

| Source | Cost (R/KWh) | Notes |
|---|---|---|
| Wind | 0.27 to 0.70 | Depending on wind regime |
| Hydro Power | 0.11 to 0.58 | |
| Biomass in co-generation and heating of boilers etc. | 0.06 to 0.80 | Depends largely on the cost of raw materials |
| Landfill Gas | 0.17 to 0.30 | |
| Wave Energy | Unknown | |

Figure 32 illustrates projected comparative energy costs as they change in future. South African electricity tariffs are among the cheapest in the world. Including the 14.2% December 2007 tariff increase, South African electricity is 61% cheaper than the USA and 68% cheaper than the UK (Fin24, 2007). With significant requirements for new installed capacity, electricity demand exceeding supply, and historically high costs of fossil fuel (including coal), it is anticipated that electricity tariffs in South Africa will continue to increase. In contrast, the cost of wind energy, for example, are projected to decline by as much as 40 to 50% over the next 15 to 20 years (Banks and Schaffler, 2006).

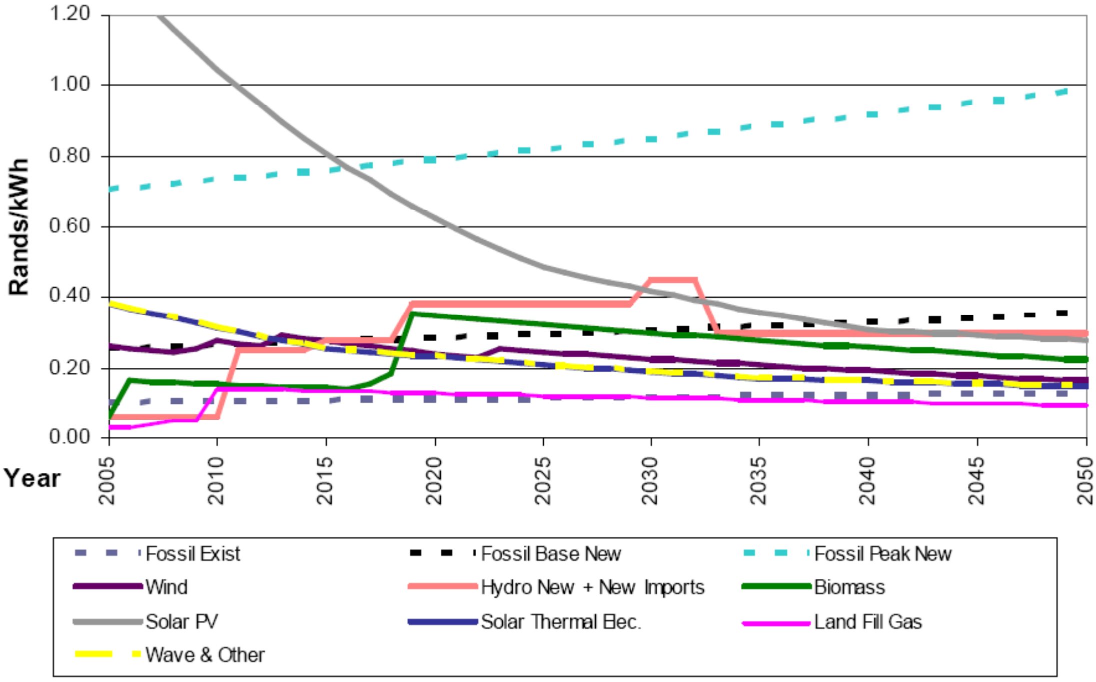



**Figure 32: Progressive Renewable Scenario: Illustration of the possible changes in cost per unit energy over time. (Source: Banks and Schaffler, 2006).**

### 10.1.3 Policy Context: South African White Paper on Promotion of Renewable Energy and Clean Energy Development

The 2002 white paper on promotion of Renewable Energy in South Africa sets the policy context for the future development of Renewable Energy (DME 2002 pg vi):

> Government's long-term goal is the establishment of a renewable energy industry producing modern energy carriers that will offer in future years a sustainable, fully non-subsidized alternative to fossil fuels.

To get started on a deliberate path towards this goal, the Government's medium-term (10-year) target is an additional 10 000 GWh renewable energy contribution to final energy consumption by 2012, to be produced mainly from biomass, wind, solar and small-scale hydro (DME 2002, pg vi).

To this end the white paper sets out strategic goals and objects including, among others (DME 2002, pg ix):

(a) Financial Instruments:

- To ensure that an equitable level of national resources is invested in renewable technologies, given their potential and compared to investments in other energy supply options.
- To set targets for the directing of public resources for the implementation of renewable energy technologies in combination with international sources of funding for this purpose.
- To introduce appropriate fiscal incentives for renewable energy.
- To extend existing state financial support systems and institutions and introduce innovative approaches to the establishment of sustainable structures and financing mechanisms for delivering renewable energy systems.
- To facilitate the creation of an investment climate for the development of the renewable energy sector, which will attract foreign and local investors.

(b) Legal Instruments:

- To develop an appropriate legal and regulatory framework for pricing and tariff structures to support the integration of renewable energy into the energy economy and to attract investment.
- To develop an enabling legislative and regulatory framework to integrate Independent Power Producers into the existing electricity system.
- To develop an enabling legislative framework to integrate local producers of liquid fuels and gas from renewable resources into their respective systems.

(c) Technology Development:

- To promote the development and implementation of appropriate standards and guidelines and codes of practice for the appropriate use of renewable energy technologies
- To promote appropriate research and development and local manufacturing to strengthen renewable energy technology and optimise its implementation.

The case for promoting industry that manufactures renewable energy technology (DME 2002 Pg vii):

Renewable Energy Technologies: It is necessary to consider which technologies can be promoted by measures to stimulate the market. In the short-term it is important that technologies that are currently available in South Africa are implemented. The local content of equipment needs to be maximised in order to minimise the costs associated with implementation and operation, as well as the promotion of employment opportunities. The establishment of technology support centres within existing research and development institutions will facilitate the promotion and ongoing development of technologies and will assist Government in the certification of systems.

## 10.2 Current and Potential Renewable Energy Projects in South Africa.

### 10.2.1 Wind Energy

South Africa is considered one of 15 countries in Africa to be viable for electricity generation from wind power. It is ranked joint 3rd below Morocco and Tunisia in terms of wind potential and institutional capacity. A wind speed map showing South Africa's Wind potential is shown in Figure 33. Wind potential along the eastern Cape Coast averages 5 to 7 m/s.

Only two wind farms currently exist in South Africa, namely Klipheuwel Experimental Farm (Eskom), and the newly established Darling Wind Power Company, both in the Western Cape. Neither has more than 10 MW of installed capacity.

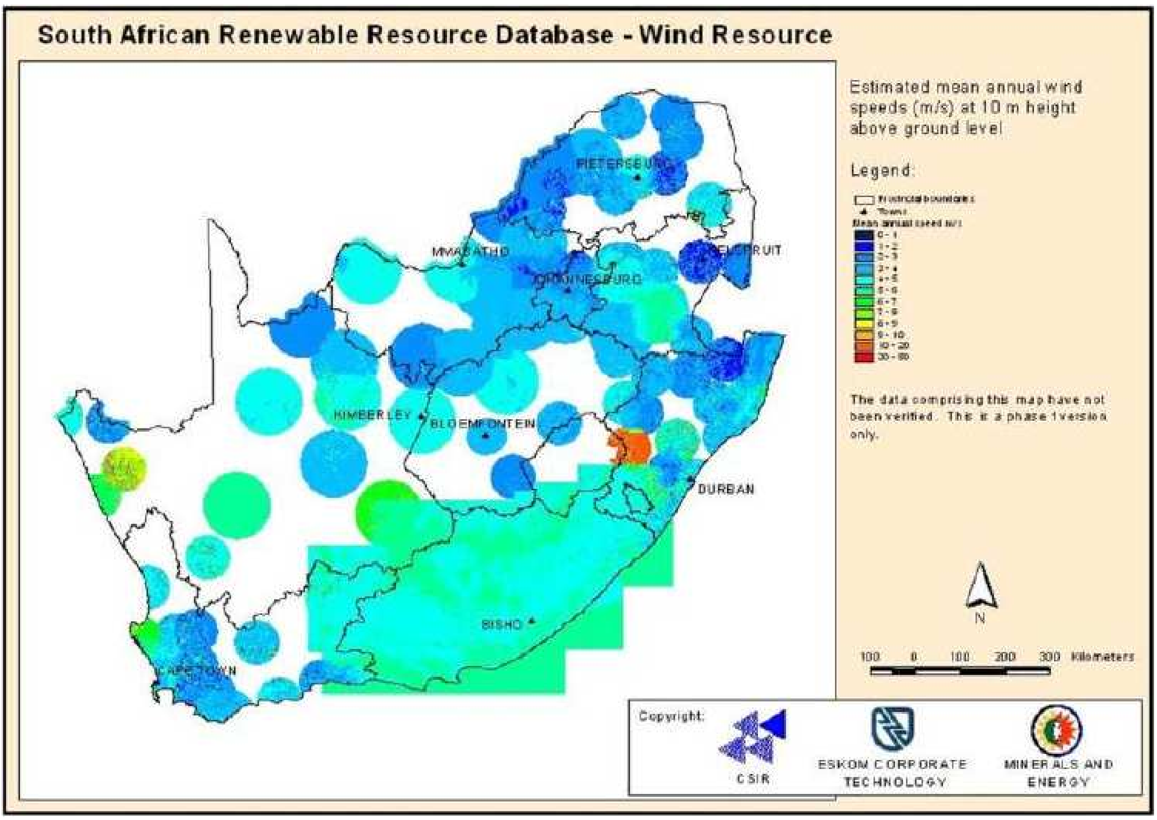



**Figure 33: Wind potential across South Africa (Source: DME 2004)**

(a) Wind Energy in BCM.

Independent studies have shown that average wind speeds in East London are, in places 6.5 m/s, at 10m above ground level (Pers Com, Kestrel Wind). Wind speeds increase with height above ground level, which means that at 60 to 80m above ground (the hub height of large turbines), one can expect adequate wind speeds for wind power generation. Extrapolations from South African Weather Service wind data for East London show that large wind turbines may have a capacity factor of between 20 and 30% in BCM along the coast (capacity factor means the *actual average* power generated by the turbine relative to its capacity were it to run at maximum capacity continuously). A capacity factor of 40% was required in 2007 for a wind turbine to compete with Eskom generation prices (African Development Bank 2004). However, with current and proposed Eskom price increases, together carbon credits from clean energy production, it is now possible that a capacity factor of 20 to 30% is competitive.

**Potential Projects**:
Large Power:
At the time of writing, large-scale wind generation (30 MW) possibilities are being investigated in BCM.

Domestic Power:
Small-scale wind turbines are manufactured in Port Elizabeth. These wind turbines are suitable for integration with household circuits.

## 10.3 Solar Energy:

South Africa has high levels of incoming solar radiation. The highest levels of solar radiation are to be found in the Northern Cape (see Figure 34). This is currently being taken advantage of by the construction of a 100MW solar thermal power plant Close to Upington in the Northern Cape. The plant will be the largest in the world to date.

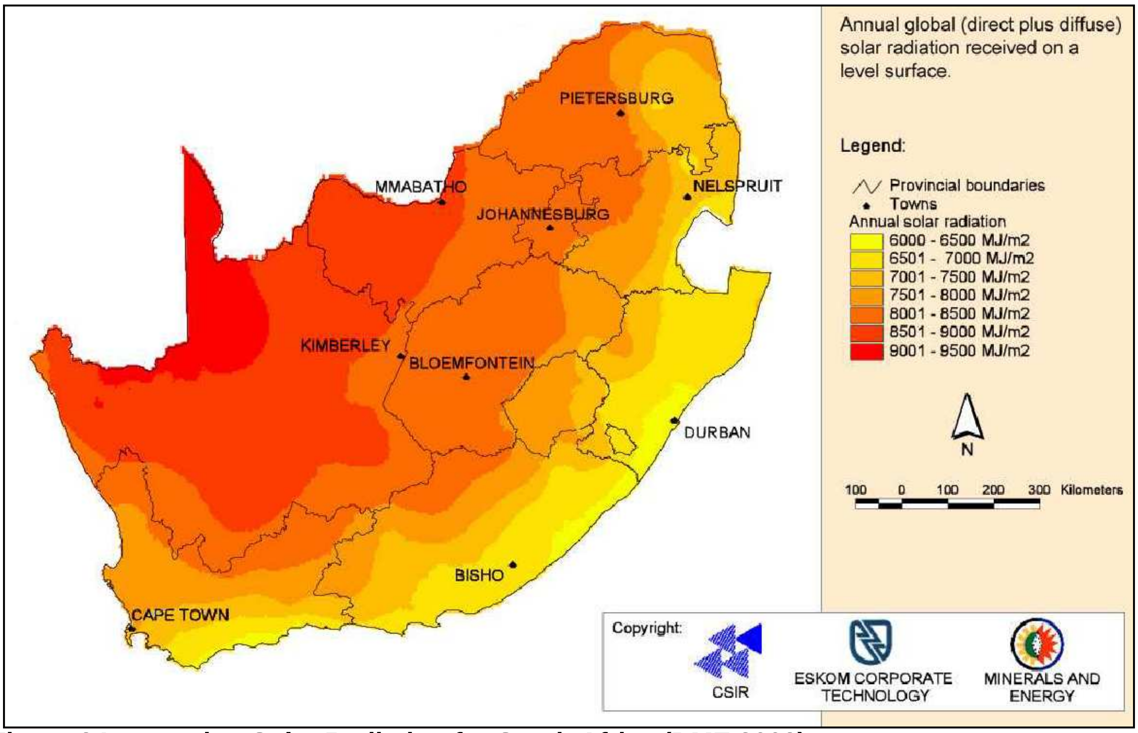



**Figure 34: Incoming Solar Radiation for South Africa (DME 2003)**

(a) Solar Energy in BCM

**Potential Projects:**

Large Power.
BCM has low levels of Solar Radiation compared with the rest of the country. As such, no large-scale solar power projects appear to have been contemplated for BCM.

Small Power:

**Solar water heaters:** Eskom has implemented a national subsidy of up to 20% for the installation of solar water heaters. With this subsidy, it is likely that a household will recover the cost of installation within 3 to 7 years, depending on the capacity and cost of the system, and bearing in mind expected tariff increases. There are currently no mass roll-out plans for solar water heaters in BCM, but installations at the domestic level appear to be increasing. Government is currently rolling out regulations requiring mandatory installation for new houses above certain sizes and values, but the details of implementing the regulation are as yet unclear.

**Photovoltaic Cells**: Due to their inefficiency, the generation of electricity from photovoltaic cells is not economically competitive as compared with Eskom prices. However, environmentally conscious households may consider installation of photovoltaic cells in combination with domestic scale wind turbines as a means of increasing the household clean energy mix.

### 10.3.2 Wave, Tidal and Ocean Current Power

South Africa has an extensive coastline with large potential ocean power resources. Currently only two projects are contemplated in South Africa, namely a 20MW wave project off the west coast of the country, and a pilot wave project off Mossel Bay. Both projects are at a feasibility stage. No projects are contemplated for the harnessing of tidal and current energy.

(a) Wave Power in BCM

The utilisation of ocean power on a large scale is still in its infancy. Despite the strong wave action and currents off the coast of BCM, no projects have been considered or recommended.

### 10.3.3 Biofuels

As a result of increasing international oil prices, biofuels are becoming more viable as an alternative to fossil fuels. Biofuels are also associated with cleaner emissions. The South African Government has passed a biofuels strategy which aims to achieve a biofuels average market penetration of 4.5 %, of petrol and diesel in South Africa by 2013.

(a) Biofuels in BCM

The East London Industrial Development Zone has established a biofuels cluster, and is promoting the development of a Biodiesel refinery that will rely on Canola as its chief source material.

### 10.3.4 Biomass

Biomass represents a renewable source of energy. Biomass, in the form of Bagasse is burned to generate electricity for refinery requirements in KZN. A certain amount of excess electricity is sold as “green” electricity via the national grid. A biomass pellet plant has been established in the Coega IDZ in Nelson Mandela Metropolitan Municipality. The plant will export 10 000 tons of pellets per month to Scandinavian Countries. Source material will be derived from alien invasive tree species such as *Acacia mearnsii* (black wattle) which proliferates in the region.

(a) Biomass in BCM

Biomass (such as Bagasse) for electricity generation in not available within BCM, although sawmills within the Amathole District Municipality may consider the feasibility of generating electricity from sawdust. However, large tracts of alien invasive vegetation may be found within a 100km radius of BCM, which would form source material for a biomass pelleting plant within BCM.

#### 10.3.5 Biogas

Putrescent waste, such as sewage, animal slurry and certain forms of landfill biomass breaks down under anaerobic conditions to form a mixture of gas containing a large proportion of Methane. Methane has 23 times the green-house gas potential carbon dioxide, and therefore has a heavy effect on global warming. In terms of global warming, it is useful to flare methane (which will attract appropriate carbon credits), while captured methane may either be compressed for resale, or combusted for the generation of electricity. Numerous projects in South Africa are at a feasibility or early implementation phase, including landfill gas to energy (Ethekweni), sewage to biogass, and slurry to biogas (mostly piggeries and large-scale dairies).

(a) Biogas in BCM

A number of biogas projects have been contemplated in BCM, including flaring and methane capture at Second Creek Landfill site, sewage digestion for biogas, and the establishment of biodigesters on certain BCM dairy farms.

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## 10.4 Renewable Energy and Independent Power Producers

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Although it is important for BCM to consider incorporating renewable energy, and especially electricity from renewable sources, in its energy mix, this does not mean that the city should actively generate the power. Numerous private entities are positioned to, and have even approached BCM with the view to, generating electricity on a private basis. BCM and/or Eskom would ultimately be purchasers (or at least transmitters) of renewable power from independent power producers. To facilitate this it is in the city's interest to cultivate a suitable policy and institutional environment for independent production of power, and the purchase of this power, by the city.

Currently the Department of Minerals and Energy is contemplating the establishment of a body independent from Eskom to facilitate and manage the procurement of power from Independent Power Producers and Co-generators (African Energy News 2008).

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## 10.5 Energy Efficiency

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Although it is important to focus on generating energy from renewable sources, it is also important to bear in mind the numerous opportunities for reducing the amount of energy that we consume. South Africa has traditionally focused on producing ever larger amounts of cheap electricity derived from large coal reserves to meet energy demand. Due to the cheapness of energy, the country has generally neglected the possibilities for reducing or managing demand. However, the South African government has recently developed a policy stance on energy efficiency, embodied in the 2005 white paper on energy efficiency.

### 10.5.1 DME White paper on energy efficiency

The Energy Efficiency Strategy for the Republic of South Africa was released by the Department of Minerals and Energy in March 2005. The vision of the strategy is, among others, to encourage sustainable energy sector development and energy use through efficient practices. The strategy sets the following targets: (Du Toit, 2007):

- A 15% final energy demand reduction for industry and the mining sector;
- A 15% final energy demand reduction for commercial and public sector buildings.

The Department of Minerals and Energy has set sector efficiency programmes with time-frames.

### 10.5.2 Energy Efficiency in Commercial and Public Sector Buildings

The South African Government intends to set per square metre energy consumption targets for public sector buildings through the SABS and DTI. Commercial sector buildings will be encouraged to conform to these standards.

In this regards energy efficiency building standards are being developed for incorporation into SANS 10400 (See Table 27)

**Table 27: South African National Standards for Buildings - Energy Efficiency Standards. (Source: Reynolds 2007).**

| Standard | Description. |
|---|---|
| SANS204-1 | Performance Requirements:<br>• Maximum energy usage for different occupancies (KW/m$^2$/annum)<br>• Maximum Energy Demand for different occupancies. |
| SANS204-2 | Energy Efficiency in Naturally Ventilated Buildings |
| SANS204-3 | Energy Efficiency in Artificially Controlled Buildings. |
| SANS204-4 | Energy Efficiency in Category 1 Buildings. |

The SANS 204 standards are currently in draft phase, and due for completion in 2008.

As an example of international benchmarks, conventional buildings utilise 300+ kWh/m$_2$/yr, while retrofitted or custom designed multi-national sustainable office buildings can achieve 115 kWh/m$^2$/yr, and small commercial office blocks can achieve 30 to 50 kWh/m$_2$/yr (Sustainable Energy Africa 2007).

Energy efficiency in large buildings can be achieved in the following ways:

- Improved efficiency in Heating, Ventilation and Air Condition (HVAC) systems;
- Improved building thermal design (applicable only to new buildings);
- Improved use of natural light;
- Fitting of energy efficient lighting;
- Computerised building HVAC and lighting management systems; and
- Installation of solar water heaters for hot water requirements.

### 10.5.3 Energy Efficiency in Industrial Processes

With regard to the industrial sector, the Minister of Minerals and Energy has signed an Energy Efficiency accord with 37 mining and industrial companies in South Africa, which has the focus of attaining agreed energy efficiency targets.

Energy efficiency in the industrial sector can be achieved in the following ways:

- Installation of energy efficient lighting;
- Pre-heating of water feeding into boilers with solar water heaters;
- Thermal savings, especially savings in the efficiency of steam generation and delivery systems;
- Compressed air savings, especially in the efficiency of generation and delivery;
- The installation of high efficiency and correctly sized electric motors;
- The installation of variable speed drives; and
- The transfer or utilisation of energy sunk into or radiated from industrial cooling systems.

### 10.5.4 Energy Efficiency in the Residential Sector

Energy efficiency in the housing sector can be achieved through the following approaches:

- Thermally efficient building design and construction, including construction of north-facing buildings, overhanging roofs, ceiling installation and insulation, and double-glazing;
- Installation of solar water heaters;
- Installation of energy efficient lighting; and
- Installation of energy efficient appliances.
- Installation of geyser blankets

### 10.5.5 Energy Efficiency in the Transport Sector

The transport sector is the principle source of energy consumption in South Africa, and therefore this requires the greatest focus in terms of energy efficiency. Energy efficiency can be achieved by the following means:

(a) Passenger Transport.
- Encouraging pedestrian and bicycle traffic;
- Encouraging a shift towards fuel efficient vehicles and/or hybrid vehicles;
- Encouraging increased private vehicle occupancy; and
- Encouraging a modal shift towards increased use of public transport. Public transport allows a much higher fuel efficiency per passenger than private transport.

(b) Freight
- Encouraging a shift towards rail freight.

### 10.5.6 Energy Efficiency in BCM

(a) Current energy efficiency project in BCM

- Conversion of Traffic Lights from energy intensive halogen lamps to energy efficient LED lights;
- Conversion of street-lights to energy efficient high pressure sodium bulbs;
- Introduction of ripple switches in domestic houses. Although this does not necessarily reduce overall electricity demand, it does however reduce peak demand;
- BCM Electricity Demand Side management target of 10% reduced demand.
- Demand side management in industry (awaiting report – Balleden and Robb);

- Eskom subsidy for solar water heaters encourages installation of solar water heaters;
- Introduction of the BCM Bus Rapid Transit System should increase fuel efficiency per passenger per trip, and encourage a modal shift from private to public vehicles; and
- BCM Forward Planning and the BCM Spatial Development Framework encourages urban densification along public transport modes.

### 10.5.7 ESCOS and Energy Efficiency

## 10.6 Carbon Trading

The global carbon trading market is expanding at an increasing rate each year. For example 1.6 billion tons of $CO_2$ emissions were traded in 2006. This increased to 2.7 billion tons in 2007 (Point Carbon, 2008). At the same time the traded value of each $CO_2$ emission is increasing. Currently one ton of $CO_2$ emissions is worth between US$10.00 and US$20.00. It is expected that this will increase to US$37.00 in 2010 and US$54.00 in 2020.

In this section, the concept and dimensions of carbon trading will be explored.

### 10.6.1 What is Carbon Trading?

The United Nations Framework Convention of Climate Change in 1992 formally recognised the significance of climate change and its link to emissions of Green House Gases (GHG). The reduction in emissions of greenhouse gasses was seen as critical to the sustainability of the global environmental systems on which we rely.

Since 1992, market mechanisms have been developed to bring emission reduction processes into the formal economy. An international mechanism was formalised under the Kyoto Protocol in 1997. The protocol sets emission reduction targets for developed countries, relative to 1990 baseline levels, for the period 2008 to 2012.

The targets cover emissions of the six main greenhouse gases, namely:

- Carbon dioxide ($CO_2$);
- Methane ($CH_4$);
- Nitrous oxide ($N_2O$);
- Hydrofluorocarbons (HFCs);
- Perfluorocarbons (PFCs); and
- Sulphur hexafluoride ($SF_6$).

As of 2007, 175 countries in addition to the EEC, have adopted the Kyoto Protocol (UNFCCC, 2007). Significantly the United States, the largest producer of greenhouse gasses, has not ratified the protocol. Developed countries that have ratified the protocol are the EU countries, Japan and New Zealand.

Three market-based mechanisms have been developed under the Kyoto Protocol to assist investment in mitigation and to help developed countries meet their GHG emissions targets:

- An emissions trading system to enable an international market for carbon credits.
- Joint Implementation (JI) of emission reduction projects between developed countries.
- The Clean Development Mechanism (CDM), which encourage joint projects between developed and developing countries. The CDM has the dual aim of reducing emissions and contributing to sustainable development in the host developing countries. The Clean Development Mechanism enables an entity of an industrial country to invest in a green house gas (GHG) reduction project in a developing country, in return for credits known as certified emission reduction units (CERU). The industrialized country may thus deduct CERU from its quantified GHG emission reduction objective, as prescribed by the KP. In addition to allowing for emission reduction, the project should contribute to the host country's sustainable development (African Development Bank, 2004).

### 10.6.2 The Carbon Currency

In order to meet emission reduction targets, developed countries can either undertake emissions reduction projects within their country, or invest in emission reduction projects in developing countries and claim emission reduction credits for this investment through the Clean Development Mechanism (CDM). This means that emission reductions can be traded between countries, and, because of regulations set by governments, within countries.

In order to facilitate the market mechanisms for reduction of GHGs, the carbon currency is denoted in terms of Carbon Credits. One Carbon Credit is equal to one Ton of Carbon Dioxide Equivalent ($CO_2e$). In other words all 6 green house gasses are expressed in terms of their equivalent in effect to $CO_2$.

Carbon Credits exist as, others:

**Certified Emission Reductions Units (CERUs):** GHG emission reductions achieved by project activities under the Clean Development Mechanism;
**Assigned Amount Units (AAUs):** The assigned amount is the total amount of GHG that each Party is allowed to emit during the first commitment period of the Kyoto Protocol (ie 2008 to 2012). This is broken down into measurable units which can be traded, e.g. either to help achieve the assigned amount or if the assigned amount is over-achieved; and
**Removal Units (RMUs)**. These are credits related to carbon 'sinks', ie eligible land use changes and forestry activities which causes the sequestration of carbon.

### 10.6.3 Carbon Trading in South Africa

South Africa is in a position to take advantage of the Clean Development Mechanism in that it is a developing country, with a high emissions baseline. For example South Africa has twice the international average per capita carbon emissions footprint. At the same time, energy is used inefficiently in this country. That means that there are many opportunities to reduce the carbon emissions in South Africa, and claim emissions reductions for doing so. As an illustration (World Bank, 2001):

- There are many opportunities to reduce GHGs in developing countries at a cost of US$ 1.00 to US$ 4.00 per t $CO_2e$.

- The cost is much higher in developed countries, with costs up to US$ 15.00 per t $CO_2$e.
- In energy efficient countries, abatement costs already exceed these figures.

This means that it is cheaper and more effective for developed countries to acquire carbon credits to meet their GHG reduction targets under the Kyoto Protocol.

#### 10.6.4 The Value of Carbon Credits

Most CDM sales transactions are private, which means that there is not necessarily an established open market price. However, based on surveys, CERs have generally been priced in the range 7.5 to 12 US$ per t $CO_2$e between 2005 and 2006 (Carbon Finance Africa, 2007).

#### 10.6.5 The potential of the Carbon Market in South Africa

The international pool of Certified Emissions Reduction (CER) currently includes only those developed countries that have ratified the Kyoto Protocol—the EU countries, Japan and New Zealand. However, it is estimated that these countries will fall short of reaching their 2012 Kyoto targets by up to 2.4 Billion t $CO_2$e.
The long-term market value will probably be much higher, as other countries take on commitments in the post-2012 extension of Kyoto and the demand for credits continues to exceed supply.The expected shortages in the compliance market for carbon credits to 2012 is presented in Table 28:

**Table 28: Carbon Credit shortfall for developed countries ratifying the Kyoto Protocol (Source: Carbon Finance Africa, 2007).**

| Market Areas | Carbon Credit Shortage (Tonnes) |
|---|---:|
| Japan | 800,000,000 |
| Europe | 1,600,000,000 |
| **Total** | **2,400,000,000** |

Considering the extent of its Coal-fired power sources and demand side energy inefficiency, South Africa has taken comparatively little advantage of the Carbon Credit Market relative to other emerging markets. South Africa currently has 10 Clean Development Mechanism projects either formally registered or with registration requested from the CDM Executive Board, representing a total of 12.4 million CERs by the end of the First Commitment Period in 2012 (Carbon Finance Africa 2007). Another 7 projects are at a validation stage, representing 7.5 million CERs. By comparison, Brazil has 106 registered or requested projects and another 112 at validation, representing a total of 151 million CERs by 2012.
However, it is estimated that 35-40 additional projects are in various stages of development in South Africa, indicating that the CDM projects are increasing at an accelerated rate.

### 10.7 Potential Carbon Trading Opportunities in BCM

To be completed by PDG.

Realistic opportunities for CDM

Guidance on regulatory and legal implications of CDM and Carbon Credits.
Identify Possible funding sources and partners for EE – CEF.

# 11 INDICATORS FOR MEASURING CHANGES IN THE ENERGY PICTURE

Indicators are types of information that can be used to show how the status of energy changes over time. They are used as benchmarks to see how the energy picture, say, fiver years from now, compares against the present. In this way, the effectiveness of interventions such as policies and other initiative can be measured. For example the effectiveness of BCM Electricity Demand Side Management, or the Eskom subsidy for solar water heater installations can be measured by monitoring average household energy use in the city over time (clearly other factors may come into play such as increased electricity tariffs).

A useful definition for an indicator (particularly in environmental circles) is given below:

*"An indicator's defining characteristics is that it quantifies and simplifies information in a manner that facilitates understanding of environmental problems by both decision-makers and the public. The goal is to assess how project activities affect the direction of change in environmental performance, and to measure the magnitude of that change" (Segnestam 1999).*

An indicator needs to be based on data that is easily obtainable but reliable, that is generated in a constant format from year to year, and/or that can be easily calculated through a standard formula. It is important to ensure that the actual recorded value of an indicator does not change from year to year because of changes in data collection and processing methodology. Rather, the change should be attributable to the influence of real factors (such as increased implementation of energy efficiency projects). In short an indicator should be simple, robust and repeatable.

A set of existing and suggested indicators is set out in Table 29.

**Table 29: List of suggested indicators, and 2007 values, that may act as a benchmark for measuring changes in the energy picture in BCM.**

| Municipality Wide Indicators | Unit | Value | Comments |
|---|---|---|---|
| **Supply Side Indicators** | | | |
| Total Energy Supplied to BCM | (GJ) | 21,837,465 | |
| Total Electricity Supply | kwh | 1,291,635,742 | |
| Total Diesel Supply | litre | 145,052,715 | |
| Total Petrol Supply | litre | 202,242,985 | |
| Total Paraffin Supply | litre | 44,895,597 | |
| **Renewable Energy** | | | |
| Electricity Renewable Sources (Purchased from outside the Municipality) | kwh | +/- 6,000,00? | Sale of electricity to MBSA – Amatola Green Power. |
| Electricity Renewable Sources (Local Generation) | kwh | 0 | None known |
| Biofuels:<br>(Purchased from outside the Municipality) | litre | 0 | None known |
| Biofuels:<br>(Local Manufacture) | litre | 0 | None known |
| Biogas<br>(Locally Generated) | $m^3$ | 0 | None known |
| **Carbon Emissions** | | | |
| Total Global Carbon Emissions caused | $tCO_2E$ | 2,679,275 | |
| **Carbon Emissions Trading** | | | |
| Total number of Carbon Emissions Reduction Projects Registered under the | Number | 0 | None Registered |

| | | | |
|---|---|---|---|
| CDM | | | |
| Total number of Registered tons of Carbon Emission Reductions Traded. | $tCO_2E$ | 0 | |
| **Sector Demand Indicators** | **Unit** | **Value** | Comments |
| **Local Authority** | | | |
| Total Municipal Energy Demand | GJ | 224,120 | |
| Number of Energy Efficiency Projects | | 3 | LED Traffic Lights, Energy Efficient Street Lights, Municipal Water Leak Detection. |
| **Commerce and Industry** | | | |
| Total Sector Energy Demand | GJ | 6,251,284 | |
| Number of Energy Efficiency Projects | | | Not Known |
| **Household** | | | |
| Total Sector Energy Demand | GJ | 2,426,176 | |
| Per household Energy Demand | GJ/ Household | 11.64 | |
| Number of domestic electricity connections | | 83,292,539 | Includes BCM Domestic, Eskom Prepaid Power Users and Eskom (non-agricultural) small power users. |
| Number of households using paraffin | | 90,153 | Includes households using paraffin for lighting, cooking and/or heating |
| Number of installed solar water heaters | | | Not Known. |
| **Transport** | | | |
| Total Sector Energy Demand | GJ | 12,404,478 | |
| Number of Registered Vehicles in BCM | | 191,355 | 2004 figures, BCM ITP |
| Public/Private Modal Split | | 60/5/4/31 | Taxi/bus/train/private. City Development Strategy, 2007. |

# 12 CONCLUSION AND SYNTHESIS OF ISSUES AND OPPORTUNITIES.

## 12.1 Summary of the energy picture

In 2007, BCM consumed 22,619,289 GJ of energy. Half of this energy was consumed in the form of Diesel and Petrol. Less than a quarter was consumed in the form of Electricity, while the remainder was consumed in the form of Paraffin, Heavy Fuel Oil, Jet Fuel, LPG, Woodfuel and Coal. In terms of sectors, more than half the energy was consumed by the transport sector, a little over a quarter was consumed by the industrial and commercial sectors, and roughly a tenth was consumed by households. Only 1% of the energy was consumed for municipal functions such as street lighting, water and sanitation services, municipal buildings, and municipal fleets.

The consumption of 22,619,289 GJ of energy in various forms caused the release of 2,679,275 tons of $CO_2$. More than half of these emissions were caused by the consumption of electricity (even though electricity makes up less than a quarter of the energy mix). Responsible for heaviest emissions was the industrial sector, followed by transport and the residential sectors.

## 12.2 Summary of Key Issues

### 12.2.1 Data

- There is no centrally available source of data. Energy related data is particularly lacking for the farming sector, the quarrying sector, industry and government (i.e. National Government Departments).
- In many cases, energy data cannot clearly be disaggregated into sectors. For example there was no means to determine what proportion of LPG gas goes to household use and what proportion goes to industry or other uses (such as restaurants).
- There appears to be discrepancy between Eskom Supply to BCM, and BCM metering and billing records. The underlying reason for this data discrepancy has yet to be determined.
- Eskom and other energy records are often based on areas of operation that do not coincide with BCM boundaries. It is difficult to determine the BCM proportion of use within these areas of operation.
- Private energy entities (such as coal retailers) are unwilling to supply data.

### 12.2.2 Energy Supply

- BCM has a heavy reliance on electricity generated from low-grade coal, causing high levels of greenhouse gas emissions. In order to maintain a sustainable city profile, and to ensure energy security, the may be a need to augment BCM electricity supply with renewable sources of electricity such as biogas, wind and solar generated electricity.
- The effects of the proposed amalgamation of Eskom and numerous municipal electricity supply entities into one RED is unclear. This means that electricity and energy forward planning is hampered.

- Energy supply to BCM is dominated by far by fossil fuels. Fossil fuels are becoming increasingly expensive, which threatens the energy security of the city.
- Half the energy supply in BCM is for transport (petrol and diesel). To effectively improve the efficiency of energy consumption in the municipality, the transport sector should receive attention.

### 12.2.3 Local Authority

- There is no monitoring (vehicle tracking system) or interrogation of the municipal fleet. This could lead to abuse of municipal vehicles, theft of fuels, and inefficiency in terms of operations.
- The option to introduce an alternative fuel source (e.g. gas) into the municipal fleet is limited by the lack of refuelling opportunities/ locations.
- Deficiencies in road infrastructure, lack of facilities for pedestrians and cyclists all impact on energy consumption.
- Fragmented settlement planning throughout BCM has obvious consequences for sustainability, requiring a more extensive and expensive transportation network and public transport system.
- The rail network and associated operations is not a municipal function.
- The Municipal Finance Management Act prevents individual projects from being financially ring-fenced. This means that there is no direct incentive brought about by the financial savings associated with energy savings.
- The possibility of BCM electricity distribution being subsumed into a regional electricity distributor is undermining current energy planning.

### 12.2.4 Industry and Commerce

- Electricity has traditionally been a cheap energy to existing businesses and industry. As such businesses have well established systems that are reliant on electricity and change to other sources may be costly.
- In response to the electricity crisis and the unreliable supply, many businesses have purchased generators which utilise petrol and diesel. While this reduces the load on the national grid, they are not considered efficient forms of energy and contribute to air pollution impacts.
- Green power is more expensive as opposed to fossil fuel generated electricity.
- To date there has been no education or awareness drive to encourage businesses to consider more efficient forms of energy.
- There are no incentives to encourage the sector to consider more efficient forms of energy consumption in terms of production.
- The legal implications of enforcing Electricity Demand Management in industry will have to be analysed.

### 12.2.5 Transport

Public Transport

- There are approximately 3 300 minibus and sedan taxi vehicles operating in East London. These taxis dominate the public transport sector, and any BCM driven public transport plan will have to ensure a well managed relationship between themselves and taxi operators and associations.
- A Bus Rapid Transit system is being planned for the city as a public transport alternative. However, tight control of the system will have to be maintained, while public security throughout the transport system will be required to ensure its success.
- Metrorail is a non-municipal function, which acts against an integrated public transport management approach.
- Deficiencies in road infrastructure, such as lack of facilities for pedestrians and cyclists all impact on energy consumption (IDP, 08/09).

Municipal Fleet

- There is no monitoring (vehicle tracking system) or interrogation of the municipal fleet. This could lead to abuse of municipal vehicles, theft of fuels, and inefficiency in terms of operations.

Freight

- Freight is dominated by road, rather than rail, haulage. Inefficiency within the rail transport system (such as double handling and long delivery time) is currently a disincentive for rail freight. Rail freight is a national competency.

### 12.2.6 Housing

- Low household income is a barrier to a transition from poor energy choices to sustainable energy choices. For example a household may be electrified, but low-income levels prevent the household from purchasing new electrical appliances.
- There may be problems with mass rollout of energy interventions in the context of the Municipal Finance Management Act.
- Mass rollout of solar water heaters in low-income areas will have positive quality of life and energy saving results. However, commercially available solar water heaters are large and expensive. A locally manufactured, cheaper solution should be investigated.
- Heavy reliance on paraffin and woodfuel causes household and local air quality issues.
- There are disaster Management issues associated with paraffin, woodfuel and illegal connections in informal housing areas.
- Fuel types such as paraffin are more expensive than electricity. However certain households do not have access to electricity. This has social equity implications.
- There are local air quality issues associated with using paraffin, as against global air quality and greenhouse issues associated with using electricity.

- Higher income urban households have a comparatively high energy consumption. Education, incentives and interventions to reduce consumption should be investigated.
- The mechanism for enforcing solar water heater installations in new large or high value houses or units (as required by 2008 electricity regulations) are unclear.

### 12.2.7 Renewable Energy, Energy Efficiency and Carbon Trading

- Although there are opportunities for renewable electricity production by independent power producers, the Municipal Finance Management Act and National Tariff Regulations prevents BCM from paying higher amounts, and charging higher tariffs, to customers willing to pay a surcharge for the "green" power. This means that IPPs must compete with cheap, coal-generated electricity supplied by Eskom.
- There is no established legal and institutional structure for the purchase of "green electricity" from IPPs by BCM.
- There is no established legal and institutional structure for the transmission of electricity from an IPP to an independent consumer via the BCM network.
- Although Eskom supplies a subsidy for solar water heaters, households still have to make a large capital outlay to purchase and install the units.
- Although the Clean Development Mechanism provides a means of subsidizing the generation of renewable energy, there are major administrative and legal requirements associated with registering a CDM project.

## 12.3 Summary of Opportunities and Initiatives

### 12.3.1 Local Authority

Opportunities

- Driver training is an opportunity to influence fuel usage (e.g. prevent excessive idling of vehicles, responsible driving techniques etc.).
- A significant energy saving can be achieved by installing energy efficient lighting in the municipal buildings.
- Methane extraction at some the city's Waste Water Treatment Works presents a possible energy source.
- Landfill gas extraction at some of the city's landfill sites presents a possible energy source.

Initiatives

- Energy inefficiency is experienced in congested traffic with standing vehicles. The city is implementing a roundabout strategy to release congestion and reduce travel speeds.

- To combat load shedding and its effect on traffic congestion, BCM is in the process of purchasing UPS technology for traffic lights at key intersections, particularly near schools where morning congestion is high.
- A strategy for retrofitting streetlight with energy efficient bulbs is in the process of implementation.
- The Electricity department has planned to undertake an audit of all municipal buildings with a view to implementing energy efficiency.
- BCM is about to implement a fuel tracking system in all of its vehicles. This will assist in controlling usage and will ultimately assist in controlling theft and wastage.
- The Mdantsane Water Loss Management Programme should reduce treated water requirements within BCM. This will save excessive pumping and treatment energy (and financial) costs.
- BCM is considering the upgrade of waste-water treatment works with technology that will facilitate 75% greater energy efficiency in treatment.
- Demand Side Management: BCM Electricity has installed ripple control units in East London. This saves peak electricity requirements. Ripple control switches will in future be installed in Mdantsane and King Williamstown as a second stage of Demand Side Management. As a third phase, ripple control switches may be installed for geysers and air conditioners of industrial and commercial consumers. However, the possibility of interfering with industrial processes will have to be avoided.
- BCM is currently drafting an Electricity Master Plan with a 5, 10 and 20 year outlook The master plan will have energy efficiency considerations.
- By-laws: BCM is currently in the process of reviewing by-laws. Energy savings will be worked into these by-laws (pers. comm. Rob Ferrier).

### 12.3.2 Industry and Commerce

Opportunities

- The attraction of East London for investment lies in its low input costs and its excellent infrastructure, including an airport and a port. It is also well connected to the rest of the country by rail and road.
- Various private organisations are interested in investing in renewable energy (wind power, methane extraction etc.).
- Carbon Credits are an untapped opportunity, both in terms of energy efficiency interventions, and the generation of renewable energy.
- The electricity crisis and high crude oil prices has forced organisations to consider more efficient and reliable energy alternatives.
- Large commercial buildings can retrofit lighting, heating, ventilation and cooling systems to reduce energy efficiency at little cost.
- The presence of Energy Saving Companies (ESCOs), may provide a useful mechanism for energy efficiency interventions in industry and commerce.

Initiatives

- Due to a strong international lobby, global industries are becoming increasingly aware of the damaging effect that the use of energy from fossil fuels and emissions have on our environment.
- The JSE requires listed companies to report on their sustainability, including energy and greenhouse sustainability, through the JSE Social Responsibility Index (SRI).
- Amatola Green Power supplies green energy to MBSA. Similar opportunities are available to other organisations.
- The East London IDZ has invested capital towards evaluating renewable energy and energy efficiency projects.
- The East London IDZ has established a biofuels cluster, and is in the process of establishing a biodiesel plant.

### 12.3.3 Transport

Opportunities

- BCM may pursue the establishment of an Integrated Transport Authority (ITA) within the municipality. The ITA will provide a mechanism for the integration of National, Provincial and Local public transport entities under one management and planning umbrella.

Initiatives:

- The recently completed Kei Rail project is a pilot project for Governments "Moving back to Rail Strategy."
- A Bus Rapid Transit system is being planned for the city as a public transport alternative.
- The current modal split in transport is as follows: Taxi 60%, Bus 5%, Train 4% and private transport 31%. The BCM Transport Planning Division has set a strategic goal to for a modal split of 80% public / 20% private by 2020. Initiatives associated with this goal include an improved rail service that will form the most important component of the "trunk" public transport network, and the Bus Rapid Transit System.
- The city has established a pilot cycle path.

## 12.4 Housing

Opportunities

- BCM together with the National Department of Housing is continually establishing new housing within BCM in an effort to reduce informal housing. Associated with formal housing is formal connection of a household to the electrical grid.
- Education about ethanol stoves.
- Education about energy cost of paraffin vs. electricity.
- Education about using second hand appliances and illegal connections.
- Opportunities for mass rollout of solar water heaters.

- Opportunities for energy efficient installations in RDP housing such as ceilings, insulation and energy efficient light bulbs.
- Opportunities for thermally efficient design of new RDP housing.
- Opportunities for improved efficiency in higher income households such as:
  - Solar water heaters (including Eskom subsidy).
  - Improved energy awareness.
  - Energy efficient appliances.
  - Household renewable sources such as turbines and solar PVs.

Initiatives

- The Potsdam Sustainable Housing Project represents a BCM, DST, CSIR pilot study for sustainable low-cost housing.
- BCM has recently been included in the coverage of the coastal condensation fund which provides an additional R7000.00 for the installation of ceilings, and the plastering, or RDP houses.
- Eskom provides a 20% subsidy for the installation of approved solar water heaters.
- New electricity regulations will require new high value or large houses or units to install solar water heaters.

### 12.4.1 Renewable Energy, Energy Efficiency and Carbon Trading

Opportunities for renewable energy production in BCM:

- Large scale wind power generation.
- Domestic scale wind and solar photovoltaic power electricity generation.
- Biofuels production.
- Biomass.
- Sewage, slurry and landfill biogas.

Opportunities for Energy Efficiency:

- Domestic installation of Solar Water Heaters.
- Installation of solar water heaters in institutions such as hospitals, prisons and schools.
- Retrofitting energy efficiency interventions in Commercial, Industrial and Government or Municipal buildings.
- Installation of energy efficiency features in industrial processes and installations.
- Incentives for higher occupancy in private vehicles and the use of energy efficient vehicles.

- Incentives for a modal shift towards public transport.
- The utilisation of Energy Saving Companies (ESCOS) to facilitate energy efficient interventions in commercial, industrial and government/local authority buildings and projects.

Initiatives:

- Conversion of Traffic Lights from energy intensive halogen lamps to energy efficient LED lights.
- Conversion of street-lights to energy efficient high pressure sodium bulbs.
- Introduction of ripple switches in domestic houses. Although this does not necessarily reduce overall electricity demand, it does however reduce peak demand.
- BCM Electricity Demand Side management target of 10% reduced demand.
- Demand side management in industry (awaiting report – Balleden and Robb).
- Eskom subsidy for solar water heaters encourages installation of solar water heaters.
- Introduction of the BCM Bus Rapid Transit System should increase fuel efficiency per passenger per trip, and encourage a modal shift from private to public vehicles.
- BCM Forward Planning and the BCM Spatial Development Framework encourages urban densification along public transport modes.

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