CITY OF TSHWANE
METROPOLITAN MUNICIPALITY

STATE OF ENERGY REPORT

26 OCTOBER 2005

Submitted by:

Africon Engineering International (Pty) Ltd

1040 Burnett Street

HATFIELD

0083

Contact Person:

Ms Linsey Dyer

Tel (012) 427 2780

Cell: 082 577 2145

Submitted to:

City of Tshwane Metropolitan Municipality

The Manager: Procurement

PO Box 48

PRETORIA

0001

Contact Person:

Jean Mostert

Tel (012) 358 3759

Cell: 082 444 3101

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

DRAWING

Vehicles and Occupancy Surveys – Tshwane All Counts

ABBREVIATIONS

CDM	Clean Development Mechanism
CONNEPP	Consultative National Environmental Policy Process
COP	Conference of the Parties
CTMM	City of Tshwane Metropolitan Municipality
DME	Department of Minerals and Energy
DSM	Demand side management
EEDSM	Energy Efficiency & Demand Side Management
EDI	Electricity Distribution Industry
EE	Energy Efficiency
EMIS	Environmental Management Information System
ESI	Electricity Supply Industry
GEOSS	Global Earth Observation of Systems
GDP	Gross domestic product
GGP	Gross geographic product
GHG	Greenhouse Gas Emissions
IDP	Integrated development plan
IEA	International Energy Agency
IP	Illuminating paraffin
ITP	Integrated Transport Plan
IPP	Independent Power Producer
LA	Local Authority
LDV	Light delivery vehicle
LPG	Liquefied petroleum gas
MOP	Meeting of the Parties
NAAMSA	National Association of Automobile Manufacturers of South Africa
NEMA	National Environmental Management Act
NER	National Electricity Regulator
NLTTA	National Land Transport Transition Act
RE	Renewable Energy
RED	Regional Electricity Distributor
RET	Renewable Energy Technologies
RSA	Republic of South Africa
SA	South Africa
SANERI	South African National Energy Research Institute
SAPIA	South African Petroleum Industry Association

SARCC	South African Rail Commuter Corporation
SoER	State of Environment Report
SWH	Solar Water Heaters
SUV	Sports utility vehicle
TIEP	Tshwane Integrated Environment Policy
UNFCCC	United Nations Framework Convention on Climate Change

FOREWORD

Energy plays a critical role in a city's economic development, social welfare and environmental sustainability. Without energy, a city would not be able to function, and economic activity would cease.

In light of global imperatives around climate change due to anthropogenic greenhouse gas emissions (GHG) as well as complex issues surrounding energy use in South Africa, the City of Tshwane's Mayoral Committee endorsed the following Energy Declaration, first introduced in 2003 by the City of Cape Town, in early 2004:

- Diversify their energy supply and increase renewable and cleaner energy sources by 10% in 2020
- Reduce energy consumption in all council operations by at least 20% in 2005
- Implement green procurement policies based on energy efficiency principles by 2007
- Pass legislation requiring solar water heaters in all new middle- to high-income housing in 2006
- Insulated ceilings in new low-cost housing must also be introduced by 2005 and retrofitted by 2007
- Bus lanes must be enforced and bicycle lanes must be introduced on at least 20% of roads by 2010
- Cities have committed themselves to develop an integrated energy strategy by 2006.

CTMM has further committed to the following added goals:

- Provision of sustainable energy that has health benefits and reduced carbon dioxide emissions and thus ensures clean air.
- Ensuring energy efficiency in Municipal Buildings, Industry and Commerce, Transport and Residential sectors.
- Promotion of energy that supports economic competitiveness and increases employment.
- Promotion of general awareness among community members on renewable energy and energy efficiency.

The City of Tshwane, as a member of the ICLEI Local Governments for Sustainability Cities for Climate Change Protection Campaign, is in the process of formulating a Local Authority Energy Strategy (LAES), which will also incorporate elements of a Climate Change Strategy. This LAES will be based on the principles of sustainable development as well on the facts presented in this State of Energy Report, which provides a baseline for assessing critical energy and climate change issues facing Tshwane. The Tshwane LAES is expected to be issued in final draft form by the end of November 2005.

This report takes into account Tshwane's own City Development Strategy, Energy Baseline Report, Air Quality Management Plan, Integrated Environment Policy and Integrated Transport Plan as well as a multitude of activities taking place in Tshwane under the Sustainable Energy Tshwane and Non-Conventional Energy Working Group in framing the issues on which a sustainable energy strategy can be formulated.

EXECUTIVE SUMMARY

1. BACKGROUND AND INTRODUCTION

1.1 PROJECT OBJECTIVE

This Report has been prepared at the request of the City of Tshwane Metropolitan Municipality (CTMM), in preparation for the development of a Climate Change and Energy Strategy within the municipality. The aim of the project is to provide a status report on the use of energy in CTMM. The project is also closely aligned to the Air Quality Management Plan, expected to be completed by October 2005.

1.2 STRUCTURE OF REPORT

This report first provides a background to CTMM, giving a brief overview of its organization as well as its overall demographic and economic profile. This section also provides a short discussion on energy in order to put the reader in context. The second section provides a thorough review of legislation and regulation pertinent to energy in South Africa and in Tshwane, in order to give a full picture of the enabling environment. The third section provides an overview of the sources of data and the validity and quality of data collected for each component of the Report. Section 4 then provides an energy balance as an overview of energy use by energy carrier, by users (demand sectors) and supply. Sections 5 and 6 detail energy demand by carrier and user and energy supply by carrier respectively. Section 7 provides a thorough assessment of environmental issues relating to energy in CTMM, as well as an assessment of greenhouse gas emissions from energy use in Tshwane. Section 8 then presents a detailed discussion on the State of Energy in CTMM, integrating the observations from the previous sections and providing conclusions and recommendations for future action by CTMM in support of the preparation of a detailed Energy Strategy.

1.3 INTRODUCTION TO CTMM

VISION

To become the leading international African capital of excellence that empowers the community to prosper in a safe and healthy environment.

MISSION

To enhance the quality of life of all the people in the City of Tshwane through a development system of local government and the rendering of efficient, effective and affordable services.

1.3.1 Administrative

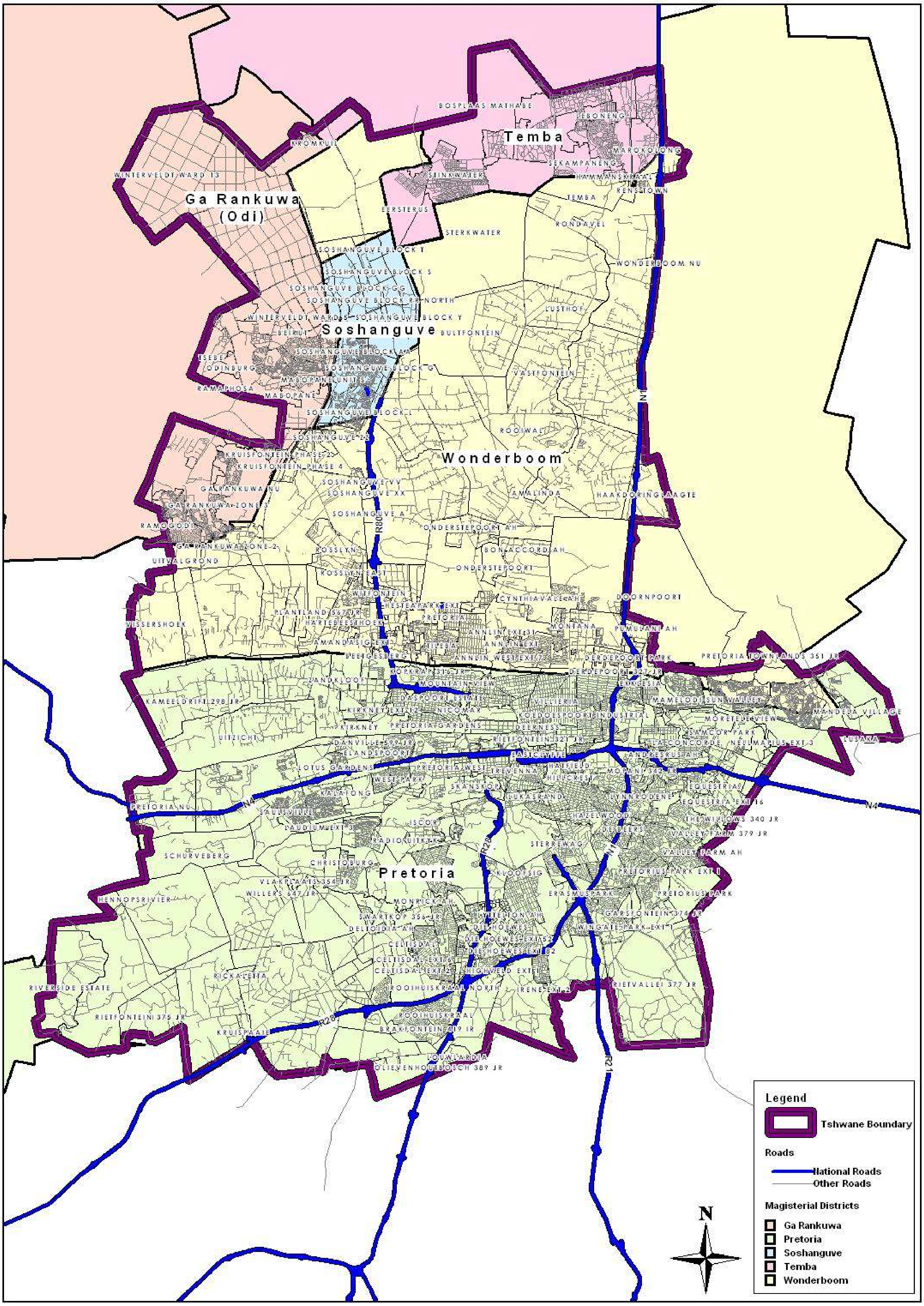
Tshwane is a vibrant, modern capital city, which has developed tremendously since the re-establishment of diplomatic ties with the international community following the demise of apartheid. Significant economic sectors in Tshwane include financial and social services, manufacturing, trade, construction, electricity, transport and agriculture.

The CTMM, a Category A municipality, was established on 5 December 2000 when a number of local authorities were amalgamated to form the new metropolitan municipality.

The Metro covers a total area of 2198 km^2 and includes the following areas, as shown in Figure 1 overleaf:

Akasia	Atteridgeville	Centurion
Crocodile River	Eersterust	Ga-Rankuwa (Odi)
Hammanskraal	Laudium	Mabopane
Mamelodi	Pienaarsrivier	Pretoria
Soshanguve	Temba	Winterveldt

Figure 1 City of Tshwane – Magisterial Districts and Major Roads



CTMM falls within two provinces, Gauteng and Northwest Province. The bulk of the city is located within Gauteng, while Temba, Ga-Rankuwa, Mabopane and Winterveldt fall partly within the jurisdiction of Northwest province, representing a need for normalisation of cross-border areas. These issues have been addressed at the provincial level, and it is expected that they will be finalised at the municipal level following municipal elections in December 2005.

1.3.2 Geomorphological

The area is divided by a natural barrier, the east-west mountain range comprising the Magaliesberg, Waterberg, Schurweberg and Bronberg, located to the north of Pretoria. Main rivers include the Sesmylspruit and Hennops rivers in the south, and the

Pienaars

Apies

Tshwane

Kutswane

Tolwane and

Swartspruit

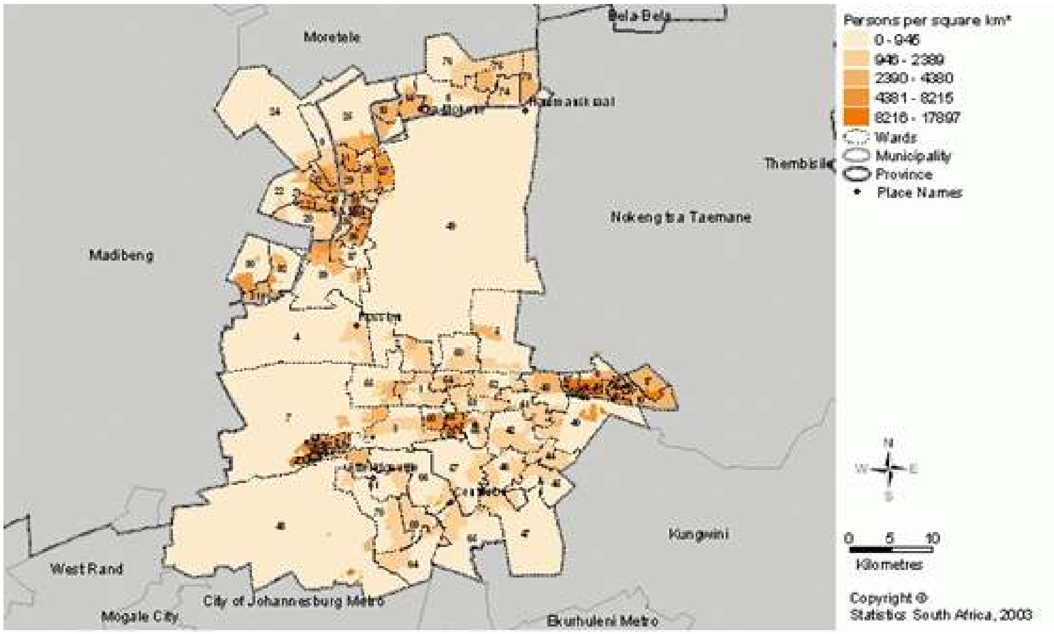
drainage basins to the north. There are three major passes through the Magaliesberg, the Baviaanspoort, Derdepoort and Wonderboompoort.

CTMM falls under the jurisdiction of the new Crocodile and Marico Water Catchment Management Agency.

1.3.3 Socio-economic

Tshwane's population was estimated to be 1 985 970 people in the 2001 census. The population distribution and density are illustrated in Figure 2

Figure 2 Population Distribution in Tshwane

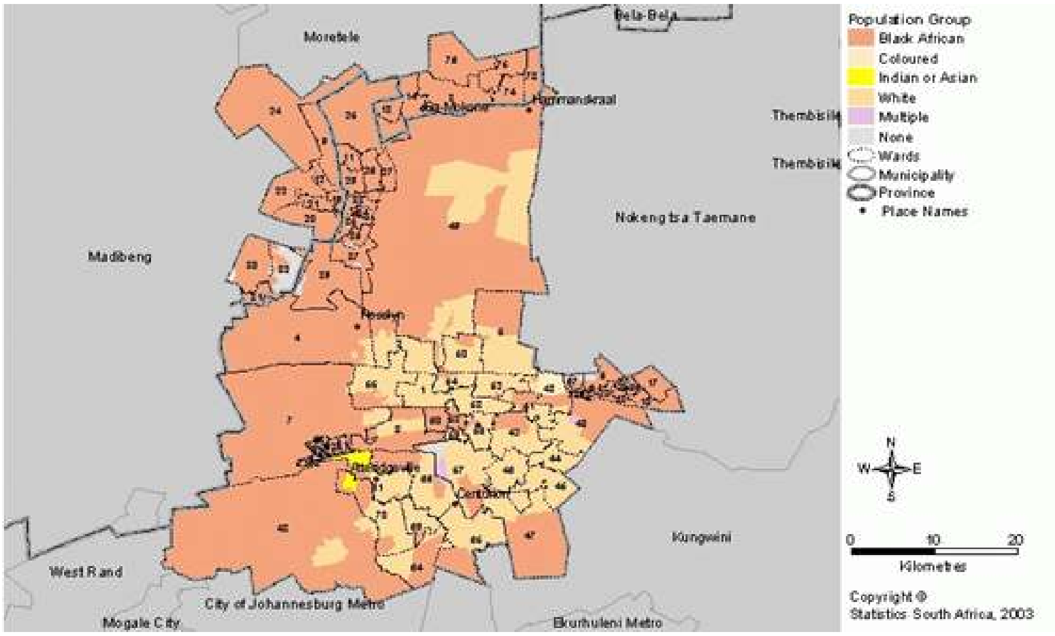


The Metro is characterised by older, residential and light commercial, relatively dense development in the south, contrasting starkly with the rural regions of the north, which represent the largest area in Tshwane.

Fragmented urban areas lie between large tracts of agricultural land and veld. Quality of life and access to basic services are much lower than in the more affluent southern neighbourhoods. Most of the poor, unemployed and young live in the main northern townships of Atteridgeville, Winterveldt, Mabopane, Soshanguve, Temba, Hammanskraal and Mamelodi. The majority of poor households (with a combined income of less than R9 600 per year) are in the north.

The distribution of residents by race was also captured by the census. This is illustrated in Figure 3.

Figure 3 Distribution of Population Groups Within CTMM



The number of households was estimated at 568 641 in 2001. Of these, 33% lived in informal dwellings and 68% had access to electricity within the northern areas.

The main issues facing Tshwane's development leaders are:

- Settlement fragmentation
- Regional mobility and accessibility
- Meeting infrastructure service delivery targets and eliminating backlogs by the target date of 2012, set by national government
- Socio-economic stagnation
- High unemployment
- Excessive growth eastwards, at the expense of north-south integration.

From a financial perspective, the municipality's balance sheet is relatively strong, and therefore the Metro is less constrained than many other SA municipalities and can consider various options to address these challenges.

The physical boundary and limited north-south access routes present an economic development challenge, as they represent constraints on the free north-south movement of people and goods. To a certain extent, they also influence strategic decisions concerning energy development.

1.3.3.1 The Challenge of the North

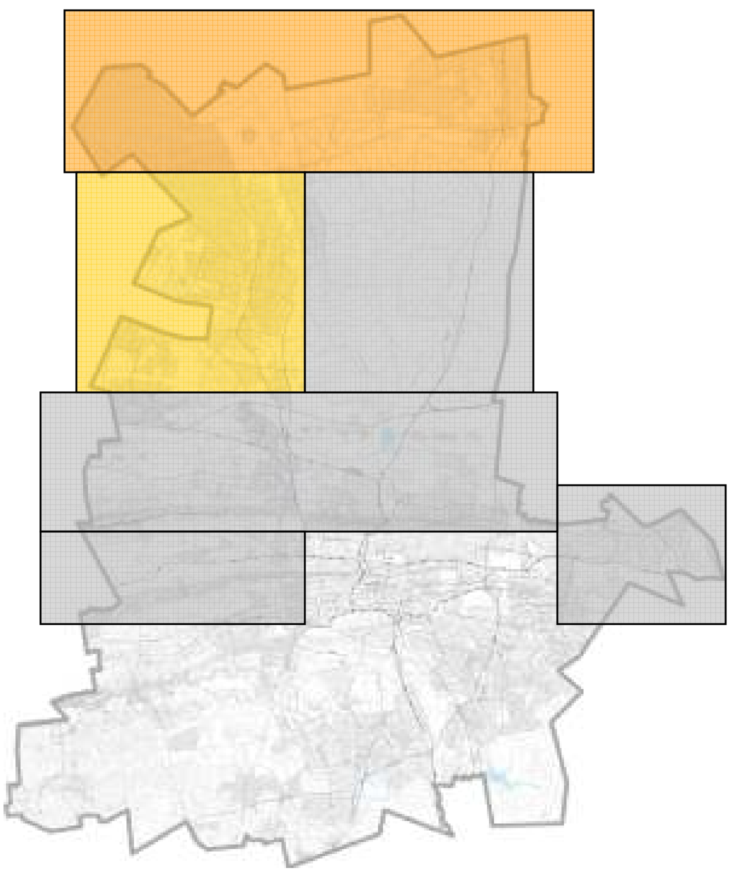
The northern and north-western areas in Tshwane include areas, which are housed institutionally under the Northwest provincial administration, posing serious challenges with respect to management of these areas. These areas are essentially rural, with low-density settlements consisting of either subsidised housing or informal settlements. Most opportunities for economic activity are in the inner city, located well to the south.

Within these areas, Babalegi and Ga-Rankuwa also consist of decentralised industrialised areas, which were previously heavily subsidised to encourage employment in the area. The road system, illustrated in Figure 1, is inadequate, compounded by the lack of reliable and safe public transport. The area is further characterised by limited social infrastructure, retail facilities, and investment by the private sector and overall rollout of infrastructure services, although, in contrast, electrification is proceeding at a rapid rate and the electricity network to the north is essentially new.

The Far North and Middle North are characterised by:

- Cross-border institutional issues, as mentioned in Section 1.3.1
- Low income
- Limited economic activity
- Historically subsidised industry
- Limited retail
- Limited investment by the private sector
- Major infrastructure backlog and constraints on management of infrastructure service delivery.

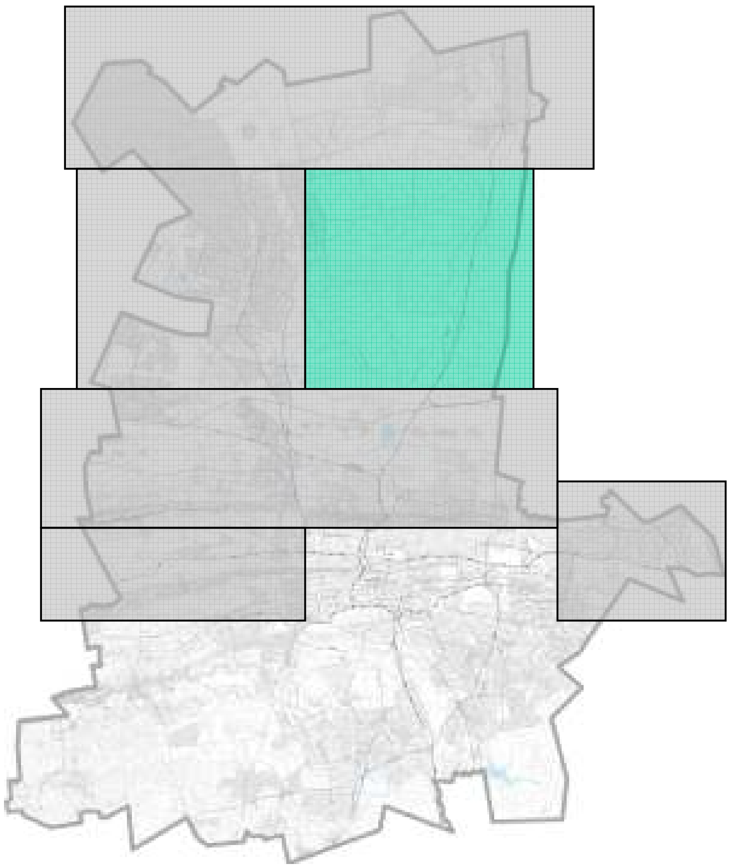
Figure 4 Far North and Middle North



1.3.3.2 Central Northern Region

This area is essentially agricultural, with a rural character and low population density. There is no commuter service to the area, although railway lines do pass through. Along the Apies River there is limited intensive agriculture.

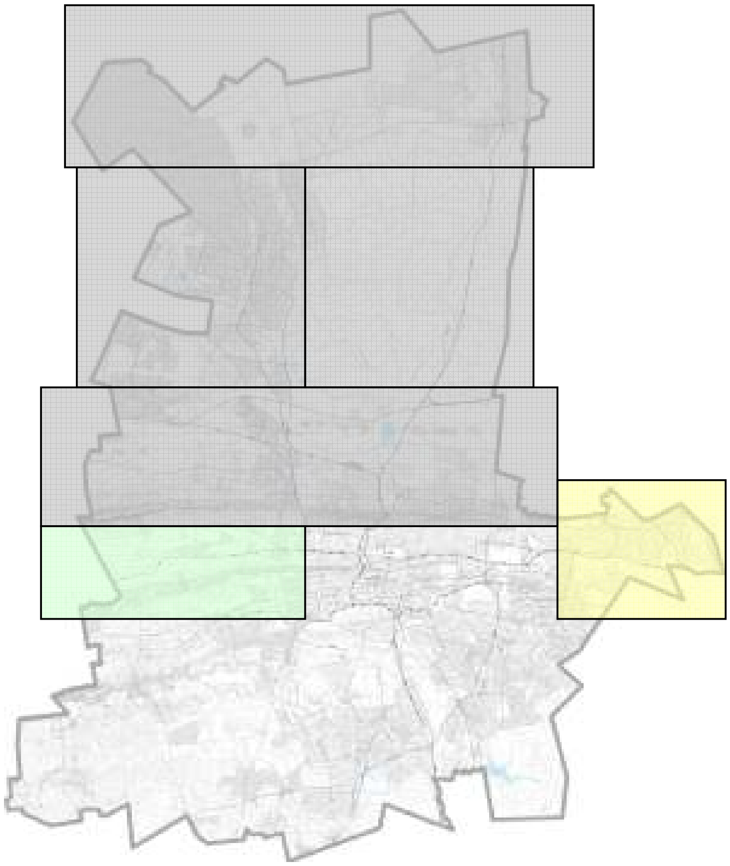
Figure 5 Zone of Agriculture



1.3.3.3 East and West

Mamelodi to the east and Atteridgeville to the west face the challenge of the legacy of apartheid planning, which included the development of large institutional tracts of land as buffer zones, making spatial integration difficult. Although they are located quite close to relatively wealthy suburbs, both these areas are characterised by limited private investment, environmental degradation and urban decline.

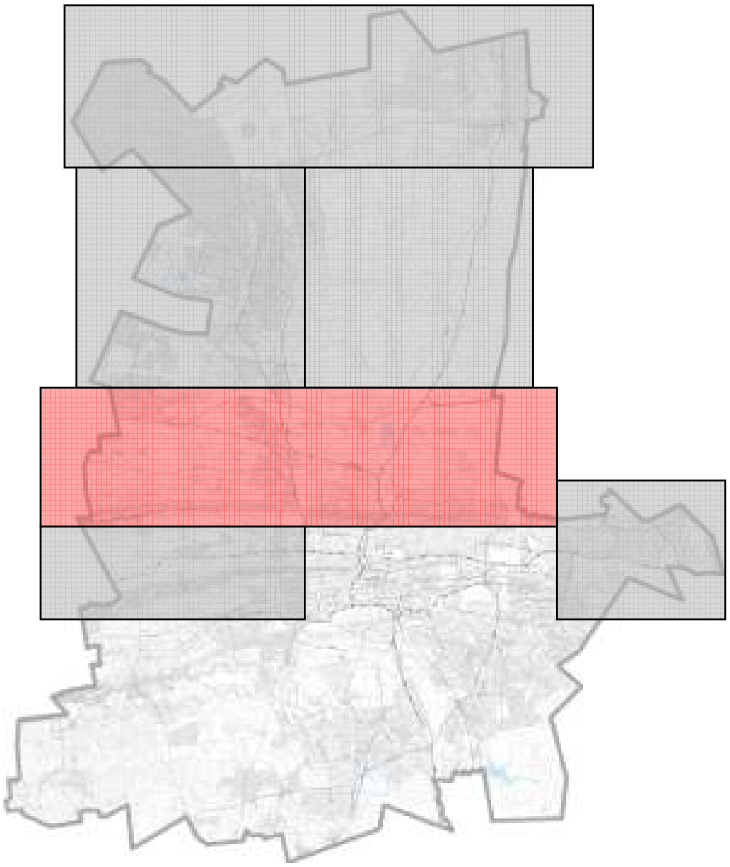
Figure 6 East and West Capital



1.3.3.4 Zone of Choice

Tshwane has chosen to focus development on the area between the Magaliesberg to the south and the N4 toll road to the north, as an initial drive to reorient development north south rather than east west. The Zone of Choice, as it is known in Tshwane, is characterised by low-density formal housing, with well-developed nodes of economic activity. It is also well served in terms of bulk infrastructure. The Wonderboom airport is situated in this region, as is the automotive cluster and the Bon Accord Dam.

Figure 7 Zone of Choice

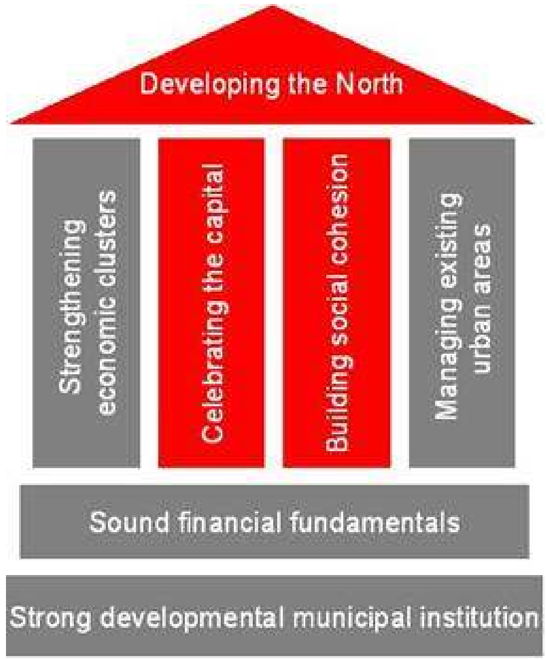


1.3.3.5 Tshwane City Strategy

Tshwane has developed a City Strategy, which consists of seven focus areas, as shown in Figure 8:

1. Infrastructure-led expansion of development potential of the North to tackle poverty
2. Continued sound management and development of the established urban areas (Pretoria Central, Centurion, South-eastern Pretoria, Mamelodi and Atteridgeville/Laudium) by maintaining services and supporting market-driven initiatives to support the overall development of Tshwane
3. Strengthening key economic clusters to gain leverage from growth trends in manufacturing, government and business services
4. Celebrating the National Capital and Repositioning the Inner City as a vibrant cultural and government centre
5. Building high levels of social cohesion and civic responsibility to maximise development opportunities
6. Ensuring a Solid Foundation: Modernising the administration for developmental service delivery through phased restructuring and institution building
7. Ensuring a Solid Foundation: Ensuring municipal financial fundamentals as platform for services and development.

Figure 8 Tshwane City Strategy



These pillars of development translate into the following building blocks for Tshwane:

- Using the North as an entry-point
- An area termed the "Zone of Choice" (see Figure 7) has been identified as a focus area for strategic investment in the North
- Transport and mobility play a pivotal role
- Public investment in the North outside the Zone of Choice will concentrate on creating places of value, nodes which will attract private investment and provide a wider range of public services and small businesses
- Areas with high quality services will pay proportionately more to support access to services in poor areas
- Tshwane will invest in affordable and diversified housing options in the inner city to help make it a more secure and safe environment and attractive for tourism.

The City Strategy outlines how Tshwane will:

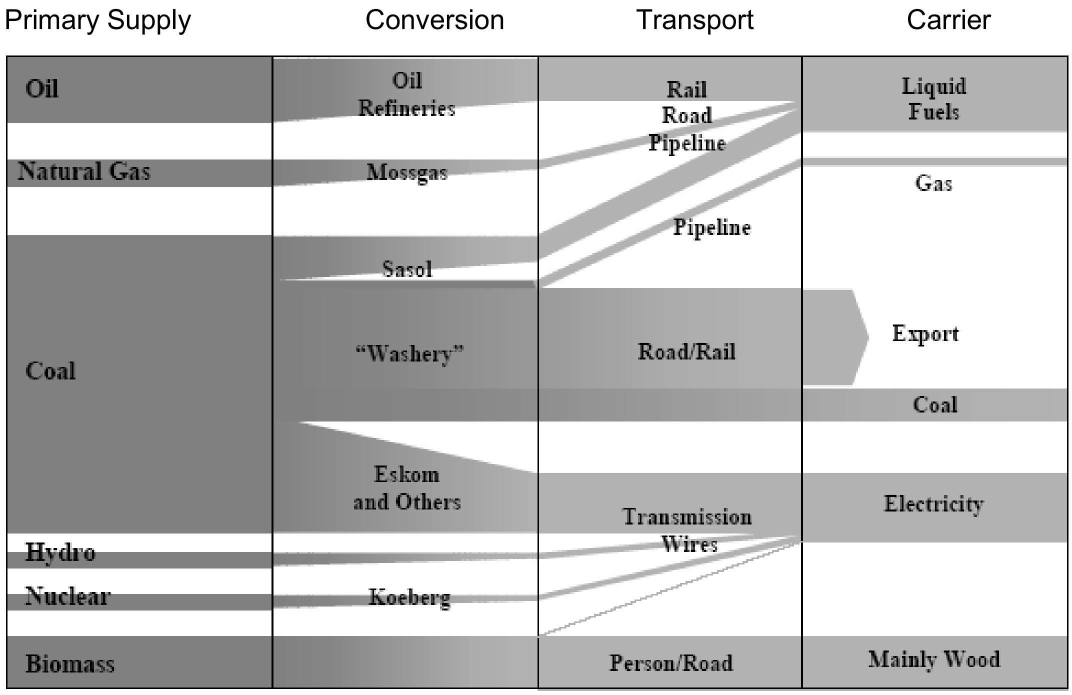
- Address the needs of the poor
- Provide high quality living experiences
- Be well connected
- Provide agglomeration benefits for growing the economy.

1.4 ENERGY IN SOUTH AFRICA

Energy in South Africa is dominated by electricity and liquid fuels supply and transport, the former mainly generated through the burning of coal in large coal-fired plants. The economy is considered energy intensive in comparison to other emerging economies. Due to the diversity of socio-economic groups in South Africa, there is still significant diversity in the role of energy in the life of ordinary South Africans. As a result of a significant drive over the last ten years to achieve access to electricity by all South Africans, the country now has an access rate of over 70%, and is continuing to connect some 300 000 households each 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.

Figure 9 provides a high level overview of the energy conversion process from supply to carrier in South Africa.

Figure 9 Energy flow from primary energy supply to final use



Source: DME Integrated Energy Plan, March 2003 (roughly to scale)

1.4.1 Security of Supply

The security of electricity supply in South Africa is under threat. The country's installed capacity is just above 37,000 MWe and the peak electricity demand is currently at 31,500 MWe. Based on the current energy consumption trends, South Africa's current installed peak generation capacity (maintaining a safe reserve margin) is insufficient to meet future forecast peak load. It is currently accepted that South Africa's reserve capacity will be used up by 2007. Commissioning a power station is usually a lengthy process that takes several years. South Africa, therefore, has a strong need to diversify its energy supply in order to ensure long-term energy sustainability and security.

1.5 CLIMATE CHANGE AND CITIES IN SOUTH AFRICA

1.5.1 General

Global climate change is possibly the greatest environmental challenge facing South Africa. Global climate change, as defined in the National Climate Change Response Strategy, is more about serious disruptions of the entire world's weather and climate patterns, including impacts on rainfall, extreme weather events and sea level rise, rather than just moderate temperature increases. Most of the impacts of climate change are associated with anthropogenic activities, in particular emission of greenhouse gases. The developing world faces greater challenges as the richer developed countries are exploiting their natural resources. Consequently, South Africa is more vulnerable to climate change. Climate Change is caused by emissions of pollutants which increase the greenhouse effect by which gases in the atmosphere create a 'blanket or warming effect' by limiting the ability of heat to be radiated out in to space. The three most common greenhouse gases are carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O).

1.5.2 Climate Change and Cities

Climate change is a crosscutting issue that could affect the entire economy as well as many specific sectors such as energy, transport, agriculture, forestry, water resources management and provision of water services and health. South African scientists have played a major role in raising awareness and its importance for developing regional, national and local responses to the threat of climate change.

Cities occupy a pivotal position with respect to climate change as major energy consumers globally. They experience special issues with respect to climate change, such as heat island effect and flash floods. This leaves cities with special responsibilities to deal with the impacts and reduce greenhouse gas emissions but also with special opportunities because of the concentration of buildings and the nature of the labour market. The relationship between climate change and cities will have a strong impact on the future well being of the human population.

It is particularly useful to think about the issue of climate change specifically in terms of how it relates to cities for three reasons:

- Over 75% of energy consumption is directly related to cities
- In many cases cities are highly vulnerable to the impacts of climate change
- Cities have a great potential to instigate innovative solutions, in the form of both adaptation and emissions reductions.

Cities are able to focus on thematic activities and their hinterlands can generate a fresh perspective on the climate issue, building awareness of the challenges and potential solutions, and fostering debate about what action is needed.

As one of South Africa's main cities, Tshwane is already experiencing the impacts and effects of climate change – effects for which adaptation and mitigation will require innovative thinking.

1.5.3 National Climate Change Conference

In October 2005, South Africa hosted the first National Climate Change Conference since the coming into force of the Kyoto Protocol in February 2005 - a ground-breaking event that brought together hundreds of scientists and policy makers from government, business and civil society to intensify efforts to use the best available science to address adaptive and mitigation actions in a coordinated manner. During his opening speech at the Conference held at Gallagher Estate, Midrand from 17-21 October 2005, Minister van Schalkwyk of Environmental Affairs and Tourism said:

> *"We must acknowledge that adaptation science in South Africa, Africa and around the world has not received the same attention or funding as mitigation, yet it is small scale agriculture and our rural farmers who will be hardest hit, especially because they are not capital intensive and often lack access to information and alternatives".*

He called for a worldwide climate change awareness campaign to demystify and mainstream climate change threat. Other Ministers highlighted the importance of water management, promotion of food security and climate change research and development strategy as a key instrument to channel South Africa's efforts.

Above all, this conference was honoured by the presence of the Deputy President, Ms Mlambo-Ngcuka who affirmed that South Africa will accept its responsibility to address climate change and will mobilize different economic sectors to meet this challenge. The conference agreed that climate change is a reality and is one of the most significant threats to sustainable development across the globe.

1.5.4 Midrand Plan of Action

The government's firm commitment to climate action and undertakings constituted the foundation of a Midrand Plan of Action that will lead the country's climate change programme into the future:

- Ensure the alignment, cohesion and coherence of government responses to climate change by coordinating and driving its climate change responses and interventions through the inter-Ministerial Committee on Climate Change, its associated Inter-Departmental Committee and the multi-stakeholder National Committee on Climate Change;
- Continue the review of the National Climate Change Response Strategy;
- Initiate a detailed scenario building process to map out how South Africa can meet its Article 2 commitment to greenhouse gas stabilization whilst ensuring its focus on poverty alleviation and job creation;
- Initiate a participatory climate change policy development process;
- Use the Air Quality Act to regulate greenhouse gas emissions and encourage a move to cleaner production, including the setting of emission standards that encourage energy efficiency;
- Compile sectoral action plans to implement the National Climate Change Response Strategy;
- Initiate a participatory national climate change research and development strategy development process that would coordinate and focus current research in a manner that delivers the critical mass of multi-disciplinary knowledge in focus areas while creating the opportunity to develop and retain human capital and research infrastructure;
- Drive increased research and innovation for the hydrogen economy using research chairs programme and provide early demonstration of technologies for 2010;
- Strengthen the South African Environmental Observation Network (SAEON) to facilitate long term climate research and establish a coordinating mechanism and establish a coordinating mechanism for South Africa's investment in earth observation as well as provide an interface with the Global Earth Observation System of Systems (GEOSS);
- Establish South African National Energy Research Institute (SANERI);

- Develop a technology needs assessment to frame a programme of action for technology transfer;
- Facilitate the development of clean technologies for climate change mitigation;
- Actively support the strengthening of the CDM, particularly a streamlined methodology review process and mechanisms to reduce transactions costs for smaller, bundled projects, during the upcoming COP/MOP in Montreal in November 2005, without reopening the Marrakech Accords;
- Welcomes Eskom's re-statement of its commitment to displacing 10% of its coal-fired generating capacity with alternative sources by 2012 and its commitment to further reductions beyond 2012;
- Ensure that renewable energy and energy efficiency are included as viable alternatives to conventional fossil fuels in government's integrated energy planning process;
- Explore new funding sources and mechanism to support the rollout of renewable energy;
- Establish the National Energy Efficiency Agency to coordinate public and private investment in energy efficiency;
- Consider climate change impacts in its water conservation and demand management initiatives;
- Review and reassess the ways in which South Africa operates its dams and quantifies the Ecological Reserve to account for a changing climate;
- Review the details of water-sharing agreements in the light of new physical realities;
- Examine the design and implementation of the water allocation reform process to ensure that climate change considerations are taken into account;
- Design and implement an outreach strategy to create awareness of the implications of climate change among stakeholders and customers in the water sector;
- Ensure that climate change considerations are included in the evaluation of new agricultural research and development projects;
- Review and revise agricultural policy to ensure climate change resilience; and
- Ensure that climate change is fully considered and reflected in the four elements of agricultural early warning systems, including: prior risk knowledge; monitoring and warning services; dissemination of warnings/information; and response capacity.

1.6 METHODOLOGY USED

The complexity of the state of energy within Tshwane necessitated the application of different methodological approaches.

At the outset, the team's approach was to assess Tshwane from an energy demand perspective, to establish the structure, characteristics and profile of the energy market. This implied the analysis of different demand sectors and their sub-sectors to determine the end uses of energy sources within the municipality. These sub-sectors were then correlated with the different energy supply options. The outcome of this analysis was a picture of multiple fuel use by different sub-sectors. From the analysis of supply options, it was possible to determine the sources of information per energy supply or demand sector.

Table 1 Pre-research analysis of energy end-use in Tshwane

DEMAND SECTORS	SUB CATEGORIES	SUPPLY OPTIONS	SOURCES OF INFORMATION
Households	Formal, Hostels, Informal, Peri-urban, Farm-workers units	Electricity, IP, Coal, Biomass, Solar, Petrol, Candles, Batteries	DBSA, StatsSA, IDP, LM, CTMM Electricity Dept, Eskom, NER, SAPIA, LPGSA, DME
Transport	Rail, Road, Aviation	Electricity, Petrol, Diesel, Gas (lifting crane), AVGAS/ AVTUR, Coal	StatsSA, CTMM, CTMM EMME/2 Model, SAPIA, LPGSA, Transnet, Spoornet, Metrorail, Gautrans, Taxi Associations, Bus Companies
Industries	Mining, Light & Heavy Manufacturing, Processing & Packaging	Coal, Piped Gas, LPG, Electricity, Renewables, All Liquid fuels	Coal Suppliers, Gascor, SAPIA, SASOL, SESSA, LED CTMM Electricity, Eskom
Commerce	Tourism, Trading, Services	Coal, Piped Gas, LPG, Electricity, Renewables, All Liquid fuels	As above
Agriculture	Commercial, Non-Commercial	Diesel, Elect, IP, Petrol, Renewables	SAPIA, LPGSA, Eskom, CTMM, SESSA, NER
Government Infrastructure	Buildings, Street Lighting, Vehicle Fleet, H_2O pumping & Treatment, Sewerage Treatment	Electricity, Diesel, Coal	CTMM, Provincial, ERWAT, RandWater
Crosscutting issues	Gender & Race, Environment, Air Quality, Energy Efficiency (EE), Health & Safety, Governance, Integrated Energy Planning (IEP), Renewable Energy (RE)		

2. LEGISLATION AND REGULATION

Most aspects of South Africa's energy sector are addressed by legislation and regulation. Electricity and liquid fuels are the subject of the most significant legislative and regulatory coverage, as outlined in the following sections.

South Africa is also in the process of formulating a National Climate Change Response Strategy, which is expected to provide the basis for concerted action plans, some of which may involve the development of further legislation and regulation.

2.1 INTERNATIONAL LEGISLATION

2.1.1 United Nations Framework Convention on Climate Change (UNFCCC)

To tackle the problem of climate change, 93 countries including South Africa have ratified the Kyoto Protocol (UNFCCC 2004). This is a legally binding commitment to constrain GHG emissions, which was adopted under the UNFCCC. Therefore many countries have begun adopting measures to reduce their emissions. South Africa ratified the UNFCCC in 1997 and acceded to the Kyoto Protocol in 2002. South Africa's Designated National Authority (DNA) was established within DME in 2005 and was officially launched at the National Climate Change Conference in Midrand in October 2005.

At present South Africa has a policy on global climate change, which has recognised that as economic growth, and development occurs so to will emissions. The utilisation of Clean Development Mechanism (CDM) and opportunities for technology transfer will play an important role in assisting with the transition to lower greenhouse gas emissions (UNFCCC 2004).

2.1.2 WSSD Johannesburg Plan of Implementation

During the World Summit on Sustainable Development held in South Africa in August / September 2002, a Johannesburg Plan of Implementation was the result of what all countries agreed to in order to eradicate poverty in the developing nations. The present plan of implementation would further build on the achievements made since the United Nations Conference on Environment and Development and expedite the realization of the remaining goals. To this end, countries committed themselves to undertaking concrete actions and measures at all levels and to enhancing international cooperation, taking into account the Rio principles, including, inter alia, the principle of common but differentiated responsibilities as set out in principle 7 of the Rio Declaration on Environment and Development. These efforts would also promote the integration of the three components of sustainable development — economic development, social development and environmental protection — as interdependent and mutually reinforcing pillars. Poverty eradication, changing unsustainable patterns of production and consumption and protecting and managing the natural resource base of economic and social development are overarching objectives of, and essential requirements for, sustainable development.

2.1.3 Millenium Development Goals

The eight Millennium Development Goals (MDGs) – which range from halving extreme poverty to halting the spread of HIV/AIDS and providing universal primary education, all by the target date of 2015 – form a blueprint agreed to by all the world's countries and the entire world's leading development institutions. They have galvanized unprecedented efforts to meet the needs of the world's poorest. The goals include the following:

- Eradicate extreme poverty and hunger;
- Achieve universal primary education;
- Promote gender equality and empower women;
- Reduce child mortality;
- Improve martenal health;
- Combat HIV/AIDS, malaria and other diseases;
- Ensure Environmental sustainability;
- Develop a global partnership for development.

2.2 THE CONSTITUTION OF THE REPUBLIC OF SOUTH AFRICA ACT NO. 108 OF 1996

The Constitution of South Africa is relevant because it is the supreme law of the Republic and the obligations imposed by it must be fulfilled (RSA 1996).

Schedule 4B of the Constitution states that electricity reticulation is an exclusive local government function.

In terms of Section 24, all South Africans have the right:

- To an environment that is not harmful to their heath or well-being; and
- To have the environment protected, for the benefit of present and future generations, through legislative and other measures that-
  - Prevent pollution and ecological degradation;
  - Promote conservation; and
  - Secure ecologically sustainable development and use of natural resources while promoting justifiable economic social development.

2.3 NATIONAL CLIMATE CHANGE RESPONSE STRATEGY

DEAT issued the National Climate Change Response Strategy (NCCRS) in September 2004. The Strategy addresses the following issues:

- International commitments, vulnerability and socio-economic implications of climate change in South Africa
  - Commitments under the UNFCCC
  - South African vulnerability
  - Economic implications
- Key issues and problems
  - Supporting national objectives and sustainable development
  - Adapting to climate change
  - Developing a sustainable energy programme
  - Meeting international obligations

  - Integration of climate change response in government
  - Government/industry partnerships
  - Domestic legal provisions
  - Climate change related education, training, awareness and capacity building
  - Climate change related research, development and demonstration
  - Inventories of greenhouse gases and air pollutants
  - Accessing and managing financial resources for climate change
- Strategic objectives, principles and proposals
  - Principles for the national climate change response strategy
  - National objectives and sustainable development
  - Institutional arrangements
  - Adaptation
  - Mitigation
  - International concerns
  - Cross-cutting issues within government
  - Legislation
  - Education, training, awareness and capacity building
  - Research, development and demonstration
  - Air quality management
  - Accessing and managing financial resources for climate change

Of the recent activities carried out in support of the NCCRS, on 17 October 2005, Business Unity South Africa (BUSA) signed an agreement with DEAT to bring about voluntary GHG emissions reporting as part of a national inventory.

2.3.1 Adaptation

The UNFCCC does not provide an explicit definition of adaptation, but rather considers it from the perspective of climate change and/or the adverse effects of climate change. The following perspective is presented by the Climate Change Knowledge Network[1]:

> *"In the context of the UNFCCC, the debate on vulnerability and adaptation centres on how to address the concerns of developing countries regarding the adverse impacts of climate change. Discussions have focused on actions to address impacts and the funding for such actions. Parties have debated the activities that constitute adaptation measures and the adverse impacts of response measures to mitigate climate change, an issue that has been strongly driven by the oil exporting states. The main question has been how to support or compensate countries affected by response measures and whether such support should be voluntary or binding.*
>
> *…In the Convention's objective (UNFCCC Article 2), it notes the need to "...achieve [stabilization of greenhouse gas concentrations] within a time frame to allow*

[1] http://www.cckn.net/compendium/int_vulnerability.asp

ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner." This provides a basis for the definition of adaptation."

In other words, adaptation to climate change refers to adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities.

The South African Country Studies Programme identified the following areas to be targeted for adaptation measures:

- Health sector
- Maize production
- Plant and animal biodiversity
- Water resources
- Rangelands

2.3.2 Mitigation

The ultimate objective of the UNFCCC is the stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. Accordingly, under Article 4.1(b) of the Convention, all Parties are required to undertake efforts to mitigate climate change.

The objective of the mitigation strategy outlined in South Africa's NCCRS is as follows:

Create a national greenhouse gas mitigation plan that furthers the process of sustainable development in South Africa in light of the CDM, technology transfer, donor funding and capacity building opportunities.

Interventions identified to address this objective are[2]:

- The efforts of all stakeholders will be harnessed to achieve the objectives of the Government's White Paper on Renewable Energy (2003) and the Energy Efficiency Strategy, promoting a sustainable development path though coordinated government policy.
- Initiating the Government's joint implementation strategy for the control of exhaust emissions from road-going vehicles
- Implement a transport sector mitigation programme through the National Department of Transport, in conjunction with the Government's energy efficiency strategy (2003) and the joint implementation strategy for the control of exhaust emissions from road-going vehicles
- Develop and implement an appropriate coal-mining sector mitigation programme through the Department of Minerals and Energy and the mining industry
- Implement sustainable industrial development through coordinated policies, strategies and incentives through the Department of Trade and Industry and the various industry sectors
- Reduce greenhouse gas emissions in the agricultural sector through the National Department of Agriculture

[2] A National Climate Change Response Strategy for South Africa, Dept of Environmental Affairs and Tourism, Sept. 2004

- Facilitate the establishment and extension of forest schemes through the Department of Water Affairs and Forestry and the forestry industry
- Optimise waste management practices to minimise the emissions of greenhouse gases and develop a government position, through all relevant departments and all spheres of government and industry, to implement a waste sector mitigation programme.

2.4 NATIONAL LEGISLATION AND POLICY PERTAINING TO ENERGY

2.4.1 National Energy Bill (2004)

The Department of Minerals and Energy is currently finalising the Energy Bill. The Bill is expected to be promulgated into law shortly, and provides for:

- The establishment of the National Energy Advisory Committee
- The National Energy Data Base and Information System
- Integrated energy planning
- Renewable energy and energy efficiency matters
- Energy safety, health and environmental matters
- Energy access by households
- International energy obligations
- Matters connected therewith.

2.4.2 Energy Efficiency Strategy

This document is the first energy efficiency strategy for South Africa. It takes its mandate from the White Paper on Energy Policy and links energy sector development with national socio-economic development plans. It provides specific targets for reduction in energy demand by 2015 within given demand sectors, with an overall target of ***12% reduction in consumption***. The target stated is expressed as a percentage reduction against the projected national energy usage in 2015. This Strategy recognizes that Energy Management Best Practice will play a vital role in achieving the national target.

Table 2 SA Energy Efficiency Strategy - Final Energy Demand Reduction by Sector

Sector	Target
Industry and Mining	15%
Commercial and Public Buildings	15%
Residential	9%
Transport	10%

Source: DME Energy Efficiency Strategy of the Republic of South Africa, March 2005

The DME has undertaken detailed research projects to assess the baseline scenario of energy usage in South Africa. This also modelled the technical efficiency interventions across the full range of sub-sectors. Energy management enables the formalisation of monitoring, evaluating and targeting energy consumption as well as providing sector-specific benchmarking information. The following sectors have all set targets for energy savings by 2015.

> ***SA Energy Strategy Vision***
>
> To contribute towards affordable energy for all, and to minimise the negative effects of energy usage upon human health and the environment. This will be achieved by encouraging sustainable energy development and energy use through efficient practices. The three cornerstones of sustainable development are embraced within the [Energy Strategy], these being environmental, social and economic sustainability.
>
> *Phumzile Mlambo-Ngcuka*
>
> *(then) Minister of Minerals and Energy*

2.4.2.1 Industrial Sector

The industrial and mining sectors combined are the largest users of energy in South Africa. Research has shown that a savings potential of at least 11% is readily achievable using low-cost to medium-cost technical interventions. Furthermore, an additional 5% - 15% energy saving is expected to be achievable via proven no-cost and low-cost techniques of energy management and good housekeeping. The Strategy envisages a reduction in final energy demand of 15% by 2015.

2.4.2.2 Power Generation

An interim target of 15% has been set for this sector based upon savings measures applicable to parasitic electricity losses only. There are two areas in which energy efficiency savings in fossil fuel power stations can be achieved:

- core business activities and
- non-core ancillary equipment.

The core business activity constitutes the thermal plant and steam turbines in existing power stations together with their immediate ancillary equipment. The efficiency is largely dictated by the technology, the size, and the age together with its existing loading characteristics. Eskom is developing a strategy to address Supply Side Management issues and targets for the existing fuel stations. The outcomes of this development are expected to be released this year, 2005.

Non-core ancillary equipment refers to the plant and equipment in support of the core business, such as compressed air, minor pumps, lighting, air conditioning and fans.

Subsequent to issuing its Supply Side Management Strategy during 2005, Eskom will incorporate the longer-term savings associated with its core business activity into the overall target for this sector.

2.4.2.3 Commercial and Public Buildings Sector

Although commercial and building sectors contribute only a small percentage to national energy usage, savings are known to be significant. Savings through low-cost and medium-cost technical interventions can exceed 25%. In order to allow for partial sectoral penetration of technical measures, however, a figure of 11% has been adopted in the Strategy, complemented by an additional 4% which is thought to be realistically achievable through managerial intervention and behavioural changes, for a total of 15%.

2.4.2.4 Residential Sector

Energy savings of 10% by 2015 have been targeted in the residential sector, which means a reduction of 1% every year must be achieved. At the national level in 2000, the sector's consumption profile was:

- Coal: 11%
- Electricity: 29%
- Petroleum products: 7%
- Biomass: 53%.

The transition towards the use of higher calorific value fuels and a reduction in the use of thermal energy consumption will be driven by energy efficiency standards in housing. However, the sector is very diverse, and many energy saving decisions lie at the individual household level, requiring an initial investment.

2.4.2.5 Transport Sector

Transport is the second largest sectoral consumer of energy and is expected to grow considerably in the medium-term. The sector has established a target of 9% of final energy demand reduction by 2015. The target is seen as challenging but realistic. The main means of transport in South Africa, both private and for the public is motor vehicles, minibuses and buses. Companies use big trucks to deliver their goods and services not only within the country but also neighbouring countries.

This means it would be difficult to implement the strategy soon without further government-supported interventions such as reliable public transport systems, safer railway transport, or carpooling. The projected savings will, therefore, only begin to impact once complimentary interventions have been implemented. Several measures will be regulatory in nature, but in order to be effective will rely heavily upon behavioural changes, which are the most challenging elements to influence.

This target is predicated on the introduction of a labelling system for vehicle energy consumption accompanied by other measures (legislative and otherwise) to promote vehicle energy efficiency on South Africa's roads, technology upgrade leading to more efficient vehicles/turnover in the vehicle park, but has excluded taxi-recapitalisation. The impact of measures such as public transport systems, moving road to rail and spatial planning are also difficult to assess at this stage and remain interventions with impacts in the long-term.

2.4.2.6 Energy Efficiency Accord

In support of the Energy Efficiency Strategy, which encourages business-led voluntary initiatives to improve energy efficiency, the Government through the Department of Minerals and Energy (DME) has established an Energy Efficiency Accord with the private sector, which emphasises as a commitment between the Government and industry to support specific objectives of the Strategy.

The main purpose of the EE Accord is to establish a mutually beneficial framework for voluntary energy efficiency initiatives that will help move the country towards its goals of attracting investment in Clean Development Mechanism (CDM) projects and efficient energy use. The Government signed this Accord with industry associations that use energy in their business operations.

In committing themselves, Parties agree to cooperate to pursue the national energy efficiency targets on a voluntary basis. They recognise that energy use is the major factor contributing to the emissions of greenhouse gases in South Africa. The success of voluntary based initiatives will form part of the regular reviews provided for in the Energy Efficiency Strategy. These Parties also recognise the national imperative to achieve higher economic growth rates and agree that energy efficiency improvements need to be considered within the context of this overarching imperative.

In simple terms this means Industry signatories acknowledged the target of a national final energy demand reduction of 12% by 2015, expressed as a percentage reduction against the projected national energy use in 2015, with a final energy demand reduction target for the industry and mining sector as a whole of 15% by 2015. This is set in terms of the Energy Efficiency Strategy.

The National Business Initiative will act as the liaison with Government in the implementation of this Accord. In this regard, Business Unity South Africa is recognised as one of the formal and representative business organisation mandated to deal with formal legislative and policy negotiations. Industry parties will collaborate with Government in the compilation of an annual National Progress Report, including energy data and progress against the agreed targets.

While there is growing recognition of the need for adoption of energy efficiency standards, most companies do not even have basic energy efficiency programmes in place. Barriers to implementing energy efficiency improvements include a low-cost coal supply, a lack of public awareness concerning operating costs of appliances, poor enforcement of the existing laws and an absence of codes and standards.

The Energy Efficiency Accord has been established to bridge these gaps and also to support the initiatives of those Companies that have started with capacity building and training programmes so as to encourage the entire industry. This will assist in strengthening the by-laws for all municipalities in the country. The main challenge for companies now is to follow suit and engage in capacity building activities that will allow them to implement systems that contribute to energy savings.

2.4.3 Renewable Energy White Paper and Strategy

In recognition of the requirement to provide adequate energy to all South Africans, as first described in the Energy White Paper (DME 1998), the Department of Minerals and Energy released a Renewable Energy White Paper in 2003 that focuses on alternative energy sources. This policy document builds on the first White Paper and provides more clarity on how a renewable energy agenda can be pursued in South Africa. An important feature of this policy document is setting a target for renewable energy. It states that:

> *"…10 000 GWh (0.8 Mtoe) renewable energy contribution to final energy consumption by 2013, to be produced mainly from biomass, wind, solar and small-scale hydro. The renewable energy is to be utilised for power generation and non-electric technologies such as solar water heating and bio-fuels. This is approximately 4% (1667 MW) of the estimated electricity demand (41 539 MW) by 2013" (DME 2004)*

Importantly, the new RE white paper provides an enabling environment for the development and growth of renewable energy businesses and opportunities. This is in light of the current imbalance between renewable and non-renewable energy resources in South Africa. Some of the policy instruments that could accelerate the production of energy from RE resources include the following:

- Financial – facilitate for investment in new renewable energy technologies (RETs) as well as extending the existing state financial systems and instruments to support RE projects
- Legal – develop a legislative and regulator framework to integrate independent power producers (IPPs) into the existing electricity system
- Technology – active support of R&D in renewable energy
- Awareness – raise community awareness to renewable energy sources and benefits in order to facilitate for community acceptance.

2.4.3.1 Draft renewable energy strategy

The RE strategy was adopted in 2004. The strategy contains timelines, concrete targets and technologies that are going to be supported by the government together with its partners. The main aim of the strategy is to provide concrete action plans on how to integrate economically viable RETs into the mainstream energy economy and lead South Africa into a path of sustainable development that supports the GEAR strategy.

The strategy has identified six core intervention areas and has drawn action plans on realizing the each objective. These areas are:

- Integration of grid and non grid technologies through addressing the market constraints, empowering local authorities with the capacity to implement viable programmes, set targets for SHS and addressing the financial barriers
- Provide RE in order to realise sustainable rural development, energisation and activation of rural economies.
- Introduce solar passive building design at a national level and particularly to the low income-housing sector. An appropriate legislation may be enacted to ensure its implementation.
- Implementation of a long-term national solar water heaters (SWHs) programme. Also, because of the energy savings and environmental benefits, an appropriate legislation may be enacted.
- A national public education, training and marketing campaign on RE will be implemented by the DME

- RETs and resource assessment and feasibility studies have been undertaken on wind energy, solar cookers, landfill gas, small hydro power systems, RE and small scale farming, women and energy, and solar thermal power generation.

2.4.3.2 White Paper on Energy Policy (1998) and Renewable Energy (2003)

The White Paper on Energy Policy was published in July 1998. The White Paper recognises and acknowledges that energy can contribute to economic growth, and employment creation as well as providing infrastructure for households. The Paper examined energy sector problems and challenges in order to determine energy policy objectives. The major policy objectives include increasing access to affordable energy services, improving energy governance, stimulating economic growth, managing energy-related environmental and health impacts and securing supply through diversity. The energy policy attempts to preserve an appropriate balance between energy demand and supply and has therefore pronounced itself on short, medium and long-term priorities.

Demand sector priorities include households, transport, agriculture, industry, commerce and mining; whilst supply sector priorities include electricity, coal, gas, nuclear energy, liquid fuels, oil and gas (exploration and production), renewable energy sources and also low-smoke fuels. It also balances the use of natural energy resources with environmental considerations. The policy recognises the need to reduce fuel wood as well as the over harvesting of natural resources which result in environmental degradation, soil erosion and desertification. The policy recognises that South Africa has neglected the development and implementation of renewable energy applications.

The White Paper on Renewable Energy emphasises and sets out advantages of renewable energy particularly for remote areas where grid electricity supply is not feasible. Government policy on renewable energy is concerned with meeting three challenges:

- Addressing constraints on the development of renewable energy industry;
- Ensuring that an equitable level of national resources is invested in renewable technologies, given their potential and compared to investments in other energy supply options; and
- Ensuring that economically feasible technologies and applications are implemented through the development and implementation of an appropriate programme of action.

The Paper encourages the use of a package of energy services such as paraffin, LPG, together with renewable energy alternatives such as solar water heaters, solar cookers, gel fuel and hybrid mini-grid systems. Such modern energy systems will not only provide better, cleaner and healthier energy services, but will also help to save the remaining woodland. The advantage of this approach is that not only is basic services provided but also sufficient power to activate and enhance the economic and job creation potential of the communities.

Although renewable technologies have higher investment costs, their operation and maintenance costs are generally lower than conventional fossil-based energy technologies. According to the White Paper, renewable energy will contribute to the diversification of energy resources through the implementation of a properly managed programme of action that will provide sufficient incentive for sustainable development of the renewable energy-based industries.

The challenge for the government is to provide sufficient incentive for the renewable energy-based industries to develop, grow and to be sustainable in the long term. The long-term goal is the establishment of a sustainable renewable energy industry with an equitable BEE share and job market that will offer in the future a fully sustainable non-subsidised alternative to fossil-fuel dependence.

2.4.4 EDI Restructuring Bill (April 2003)

The EDI Restructuring Bill was published in April 2003. The Bill provides for the establishment a national framework for the restructuring of the distribution industry, the creation of regional electricity distributors, and the management of the restructured electricity distribution industry.

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.

2.4.5 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
- Asset 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.

2.5 ELECTRICITY LEGISLATION

2.5.1 General

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.

2.5.2 Service level issues

Service levels are dealt with under the national supply regulations (NRS) issued by the NER. The NRS 047 is the quality of service standard (i.e. it regulates the relationship between customers and the licensees). The NRS 048 is the quality of supply standard (covering quality of supply parameters and minimum standards to be applied as measures of power quality at the point of supply to end consumers).

2.5.3 NER licenses

CTMM Electricity and Eskom Northern Region are licensed by the NER to distribute electricity. Both Rooiwal and Pretoria West power stations are licensed by the NER to generate electricity.

2.6 OTHER RELEVANT NATIONAL LEGISLATION

2.6.1 Legislation on municipal governance

Apart from EDI and electricity sector-specific legislation, electricity supplying local authorities is subject to various Acts relevant to local authorities in general.

2.6.1.1 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 LA 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.

2.6.1.2 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).

2.6.1.3 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.

2.6.2 National Environment Management Act, 107 of 1998

The purpose of NEMA is to give effect to the management of the environment articulated in the White Paper on Environmental Management Policy, which resulted from the Consultative National Environmental Policy Process (CONNEPP). It gives effect to the principle of co-operative governance and the environmental rights enshrined in the new Constitution. This Act provides the framework for environmental policy in South Africa, and addresses such issues as air, water and marine pollution, deforestation, energy efficiency and the conservation of biodiversity.

2.6.3 Air Quality Management Act, 2005

The Department of Environmental Affairs and Tourism (DEAT) proposed draft legislation for new ambient air quality standards for industries. The National Air Quality Management Bill replaces the outdated 1965 Atmospheric Pollution Prevention Act (APPA). This Bill which was promulgated to an Act in February 2005 aims to control air pollution, emission of greenhouse gases, and ozone-depleting pollutants by setting permissible concentrations of several polluting substances as well as total emissions levels.

The Air Quality Act, No. 39 of 2004 aims to reform the law regulating air quality in order to protect the environment by providing reasonable measures for the prevention of pollution and ecological degradation. This also secures ecologically sustainable development while promoting justifiable economic and social development. The Act provides for national norms and standards regulating air quality mentoring, management and control by all spheres of Government for specific air quality measures and for matters incidental thereto.

According to the Constitution, every South African has a right to live in an environment that is not harmful to health or well-being. As municipalities have executive authority in respect of air pollution, they are legally required to control air pollution and maintain an acceptable air quality. South Africa also faces logistical issues in combating air pollution. Currently, the Durban South SO_2 Management System is the only approved air testing facility in South Africa.

In addition, there are administrative and judicial hurdles. To date, local governments have done little in the way of monitoring air pollution or enforcing municipal standards. For example out of the 284 South African municipalities, only 131 performed air quality monitoring and of those, only 97 took steps to assure compliance and there is no penalty imposed for non-compliance. With the promulgation of the Air Quality Act, the national executive and municipal authorities will jointly carry out monitoring countrywide. Enforcement by national and local courts is a critical component to ensuring compliance with national environmental protection legislation.

Discussion is underway between DEAT and DME on collaboration with respect to monitoring of boiler emissions and efficiency.

2.6.4 Environment Conservation Act of 1989

The Act aims to ‘provide for the effective protection and controlled utilization of the environment’. Section 2 of the guideline document describes activities which might have a detrimental impact on the environment, and which therefore require an environmental assessment.

2.6.5 Agriculture White Paper (1995)

The White Paper emphasises the promotion of agricultural development, which is dependent on the protection of land and water resources. South Africa is a country lacking sufficient water supplies. It is also characterised by scarcity of potential agricultural land. The White Paper on Agriculture emphasises food security. The national government is committed to support the full spectrum of production system and practises, from urban food gardens and small-scale production for household income and food security to large-scale production systems, which can add considerably to national food security. The White Paper recognises urban food production as a strategy to reduce insecurity within South Africa’s increased urbanised population.

However, the focus of the Department of Agriculture, regarding food security is on the rural poor, who are prioritised for funds and support. The respective provincial departments within the country support urban agriculture. The Agricultural Policy was drafted to support the White Paper and it ensures equitable access to agriculture and promotes the contribution of agriculture to the development of all communities, society at large and the national economy, in order to enhance income, food security, employment and quality of life in a sustainable manner. Sustainable agriculture refers to farming systems, which are productive, economically viable and environmentally sound over time. Agriculture is an important sector for social and economic growth and development, particularly in rural areas and therefore it is recognised and promoted as such.

2.6.6 National Land Transport Transition Act (2000)

This piece of legislation, which governs the planning and management of transportation on a national, provincial and local government level, provides guidelines and regulations for the provision of regulatory bodies. Such bodies, such as local transport authorities, have powers to monitor and regulate the provision of public transport and transport infrastructure within an integrated development environment. This, along with a principle of “minimising adverse environmental impacts”, provides a platform whereby transportation planning officials can promote energy en environmentally sustainable transportation systems.

2.7 PROVINCIAL AND MUNICIPAL LEGISLATION AND POLICIES

2.7.1 Provincial Legislation and Activities

The provincial government requires that infrastructure services be delivered to households within the context of a town-planning scheme. In terms of the Gauteng Townplanning and Townships Ordinance (15/1986), infrastructure services (including electricity, water and sewerage connections) can only be delivered to housing which is on proclaimed land. The Surveyor-General must proclaim Land.

Recent initiatives by the Gauteng Department of Local Government (DLG) to develop consolidated plans to address electricity, water and sanitation backlogs in each of the province's municipalities are expected to have an impact on CTMM's energy strategy. Furthermore, Tshwane is currently finalising a high-level City Development Strategy, which focuses on energy, among other infrastructure sectors, as a lever for growth in the Metro, particularly in the north.

2.7.2 Municipal By-Laws

In 2003, Tshwane promulgated Standard Electricity By-Laws, which cover general and specific conditions of supply, systems of supply, measurement of electricity and requirements relating to electrical contractors. There is some overlap between these by-laws and the national Electricity Act.

2.7.3 Tshwane Integrated Environmental Policy (TIEP) (2005)

The Tshwane Integrated Environmental Policy (TIEP) promotes environmental responsibility by impacting in a practical manner on municipal operations and procedures undertaken by various departments within the CTMM. The TIEP is guided by a number of principles of which their implementation is guided by national and provincial legislation and policies.

General policy principles of the TIEP include sustainable development, environmental justice, community well being and empowerment, ecological integrity and minimisation of negative environmental impacts, integration of environmental considerations into decision-making, best practice environmental solutions and management, realisation of the integrated nature of ecosystems, reducing the ecological footprint of the city, internalisation of environmental costs, consideration of full environmental costs and many more. The policy provides a broad holistic framework for integrated environmental management within the CTMM, structured around strategic issues, goals and objectives. The goals and objectives serve to inform the various CTMM departments of the importance of including environmental issues and considerations in their current planning and developmental, maintenance and operational duties and responsibilities.

The CTMM's IDP was identified as a valuable tool through which the TIEP would be implemented in the CTMM. Education and awareness was identified as a vital tool throughout the implementation of the various levels of environmental management for the CTMM.

The CTMM State of the Environment Report (SoER) and the Environmental Management System (EMIS) are tools that enable the execution and implementation of the TIEP. TIEP was designed as a flexible document with the ability to adapt to the constantly changing environment of the CTMM and therefore it would be audited and revised for relevance, accuracy and practicality. Progress, implementation and integration of the TIEP are monitored and evaluated. The over-arching guide to the TIEP is the Constitutional Responsibilities to the Environment at all levels of government.

2.7.4 CTMM Integrated Transport Plan (2004/5 to 2009/10)

The Integrated Transport Plan (ITP), required by the NLTTA from every municipal authority, details the transportation infrastructure and public transport planning in detail. The ITP provides details as to the status quo of transport systems, and indicates strategies, linked to projects in the proposed budget, which would achieve the goals and objectives outlined by the City.

The goals of the CTMM ITP include reduced environmental impacts, the promotion of public transport and the improvement of access and mobility. All of these goals will lead to the improved energy efficiency in the future.

Due to the large potential influence of the increased utilisation of public transport on the use of energy, the emission of greenhouse gasses and the requirements for environmentally damaging infrastructure, the public transport planning included in the ITP is of relevance to any study of current and future energy consumption in Tshwane.

3. DATA ACQUISITION

A base year of 2004 (calendar) was selected for the data as it was determined the bulk of the data was available on a monthly basis for this period.

3.1 DATA SOURCES

For the initial data collection phase, data has been gathered from a variety of sources:

- Liquid fuel, pipeline gas and electricity data was obtained in spreadsheet form from the supplier databases. The data was then recast into the different sectors of use of the specific type of energy. In most cases this process is clear and direct, in others some interpretation or the use of expert assumptions is required.
- Processed/published data for total energy use, costs, sources and efficiency of energy supply.
- Electricity data was supplied by CTMM's Electricity Department and Eskom Menlyn. Further electricity information and data was obtained from CTMM's December 2004 submission to the NER, as well as published data on the Department of Minerals and Energy's website.
- Review of energy legislation and regulation and review of environmental impacts, with an emphasis on air quality and CO2 emissions.
- Most information for Renewable Energy (RE) and Energy Efficiency (EE) was gathered from Eskom DSM and Bonesa.
- A review of similar reports such as City of Cape Town State of Energy Report and the Tshwane State of Energy Report.
- The environment information is mainly derived from international reports and the draft Tshwane Air Quality Baseline Study. Other sources of information are United Nations Framework Convention on Climate Change (UNFCCC) website, World Resources Institute and related websites.
- Local Government Institutions, transport and the related energy use data were obtained by interviews with Tshwane officials.
- Household energy data was obtained through a survey administered during the period 19-30 September 2005.

3.2 SUPPLY SIDE DATA

3.2.1 Liquid fuels

The oil companies that are active in the distribution of liquid fuel collect their sales data on a monthly basis per magisterial district and fuel type. It is centralised in a database that is maintained by Caltex, the company responsible for national statistics. This database is also made available to SAPIA. An extract from this database for 2004 for four of the five magisterial districts that make up CTMM (Ga-Rankuwa, Pretoria, Soshanguve and Wonderboom) was provided to the Africon team by SAPIA and was used as the basis for liquid fuel data in the energy balance and sectoral use of liquid fuels. SAPIA indicated that the Temba magisterial district could not be found on their database.

3.2.2 Electricity

The main electricity supply data sets include the following:

o Generation and cost data for Rooiwal power station	July 2004 to May 2005
o Generation and cost data for Pretoria West power station	January 2004 to June 2005
o Electricity purchases from Eskom, Rooiwal and Pretoria West	January 2004 to June 2005
o Distribution losses	July 2003 to June 2004
o Sales budget information for 2005	January to June 2005
o Electricity medium-term expenditure budget	2004/05 – 2006/07

3.2.3 Pipeline gas

Pipeline gas is distributed directly by Sasol gas within Tshwane through three points, Babelegi, Rosslyn and Pretoria West. Sales data from the July 2003 to June 2005 for each of these points was obtained directly from the marketing office of Sasol Gas as given in Section 6.2.

3.2.4 Renewable energy and energy efficiency

Renewable energy and energy efficiency information come mainly from processed information by Eskom DSM and Bonesa. The latter has recently released a report outlining the energy efficiency activities undertaken in major parts of the country including CTMM. However, information specific to CTMM was difficult to isolate.

3.3 DEMAND SIDE DATA

Demand consists of:

- actual consumption
- suppressed demand (for electricity, consumption which would have occurred if load shedding had not taken place)
- latent demand (demand which is not converted to consumption due to constraints in availability of the product or ability of the market to purchase the product).

These next sections generally deal with actual consumption, except where otherwise specified.

3.3.1 Energy carriers

3.3.1.1 Liquid fuels

No independent demand data was available, so for the purposes of this study, demand is considered equal to supply. Further studies should examine losses in the supply chain and assess areas where demand may be suppressed due to distance from supply.

3.3.1.2 Pipeline gas

No independent demand data was available, so for the purposes of this study, demand is considered equal to supply. Further studies should examine losses in the supply chain and assess areas where demand may be suppressed due to distance from supply.

3.3.1.3 Electricity

Demand was assessed in terms of consumption, i.e. electricity billed by CTMM and Eskom to consumers.

The electricity distribution license is held by CTMM, although Eskom is also licensed to distribute electricity within some areas in the CTMM boundary.

CTMM data concerning specific demand sectors was derived from CTMM's submission to the National Electricity Regulator (NER), December 2004. Own consumption (which includes own use, sales to other departments and street lighting) could not be derived from this submission.

The information included in the report has been extracted from the following main sources:

o CTMM sales data for large power consumers (<10 GWh per year)	January 2004 to June 2005
o CTMM sales data for large power consumers (>10 GWh per year)	July 2003 to June 2004
o Eskom prepaid customer information	Number of customers and estimated monthly consumption (Jan – Dec 2004)
o Eskom conventional meter customers	January 2004 to December 2004

The information above was reviewed but was not independently audited.

3.3.1.4 Coal

The data for coal was procured from merchants who supply coal in CTMM for the calendar year 2004, generally on a monthly basis. The data provided was not independently verified.

3.3.1.5 Biomass

No data was received for biomass, as it is mainly non-commercial and non-monetised. It is necessary to institute a study in future to determine the consumption of biomass in CTMM. This is necessary as the unsustainable harvesting of woodfuel – a commonly used biomass in rural communities, such as the north of Tshwane – has an adverse impact on the environment.

3.4 ENERGY USERS

The most information on energy users is available through the census and focuses on household energy users. The Standard Industry Classification (SIC) is used to aggregate data for other users, including industry and construction, mining and quarrying, commerce, local government, agriculture and transport. In general, these classes of energy users have not been profiled in a detailed fashion in this study, with the exception of the transport demand sector.

3.4.1 Household Energy Survey

The project team carried out a household energy survey for the purposes of this project. The survey questions are presented in Annexure 1.

Background. The Household Energy Survey was conducted using field-administered 4-page questionnaire involving primarily objective, closed-ended questions. The Africon-Menyetla team designed and reviewed the questionnaire extensively before finalising it.

It was agreed that the survey would be based on a modified quota sample, i.e. by selecting a group of nine (9) areas felt to broadly represent the range of household types in Tshwane. These areas were:

1. Soshanguve
2. Mamelodi
3. Hammskraal
4. Attridgeville
5. Ga-Rankuwa
6. Centurion
7. Lynnwood
8. Waterkloof
9. Moreleta

Within each area, a 2% quota sample of households was targeted, based on census information on the total population of households. The sample sizes and other relevant information are summarised in the following table:

Table 3 Household Energy Survey: Areas surveyed and sample sizes

Area Selected	Household Population	2% Sample Size
Soshanguve	78,868	1,577
Mamelodi	46,203	924
Hammskraal	32,382	648
Attridgeville	29,903	598
Ga-Rankuwa	14,198	284
Centurion	13,721	274
Lynnwood	11,470	229
Waterkloof	8,340	167
Moreleta	7,658	153
Total	**242,743**	**4,855**

A group of 30 fieldworkers was selected with assistance from the Speakers' Office, and these fieldworkers received basic interview training with assistance from Menyetla staff. The first training session took place at the Speakers boardroom and 63 copies were distributed. These copies were used for field worker training and returned on 19th September 05.

A second training session took place on the 19th of September 2005, where difficulties experienced by the fieldworkers with regard to the questionnaires and household perceptions were discussed. During the same training session, 881 questionnaire copies were handed out to field workers to undertake the survey.

The full survey was conducted from September through mid-October, and data entry for about half of the survey was still being completed at time of preparation of this report. As of 21 October, the 30 fieldworkers had administered a total of 4,640 surveys. An additional 215 surveys were still due to be completed. A total of 2,343 surveys have been analysed, distributed as follows among six of the nine major areas:

Table 4 Major areas

Area	*Number of Households*
Atteridgeville	68
Hammanskraal	169
Ga-Rankuwa	60
Mamelodi	423
Matebeleng	3
Soshanguve	596

In addition, Eskom is carrying out an extensive survey of household lighting patterns in Ga-Rankuwa. This survey is being rolled out to some 35 000 households and is expected to be complete by the last quarter of 2005.

3.4.2 Industry and Construction

Non-electricity data for this demand sector was obtained from DME reports.

3.4.3 Mining and Quarrying

Non-electricity data for this demand sector was obtained from DME reports.

3.4.4 Commerce

Non-electricity data for this demand sector was obtained from DME reports.

3.4.5 Local Government

Various municipal departments were called and questionnaires faxed to elicit energy data from them. Most of the data for local government energy usage was obtained from CTMM's Department of Transportation. The electricity consumption for local government was obtained from CTMM's submission to the NER.

3.4.6 Agriculture

Data for agricultural demand was obtained from DME reports.

3.4.6.1 Transport

Data for transport demand was obtained from DME reports and from traffic counts carried out within CTMM. Transport data was obtained from specific CTMM departments with vehicle fleets and transport institutions associations based and operating within CTMM. Vehicular traffic was modelled in terms of vehicles size (light/heavy) and fuel type (diesel/petrol).

Latent demand for transport was not considered, as the levels of congestion in Tshwane are sufficiently low to allow the assumption that movement is not restricted by a lack of capacity. Vehicle ownership and accessibility to transport are more significant influences.

3.5 DATA QUALITY, AVAILABILITY AND VALIDITY

Data availability varies, especially at a disaggregated level. Those energy carriers that are supplied from centralised systems (electricity) or have centralised data systems (liquid fuels) are in a position to supply detailed data. This data is collected per marketing channel or tariff class that in many cases indicates the sector where the energy is used. Where this is not the case this allocation has to be done on an expert basis and by interpreting the liquid fuel data of SAPIA and the DME.

The data is of good quality at the aggregated level except for coal, LPG and IP where no centralised marketing or data system exists. It is assessed that the inaccuracies that come from this situation are not material in terms of the results, conclusions or priorities of this project.

Table 5 overleaf shows the level of disaggregation of the main data sets.

Table 5 **Source and level of disaggregation of data**

DATA SET	LEVEL OF DISAGGREGATION	DATA SOURCE	COMMENTS
Electricity supply and sales information for the 12 months ended 30 June 2005 (CTMM)	Large power consumers Could also be disaggregated to the customer level if necessary	CTMM Electricity Department	There is a mismatch between power station and CTMM Electricity Department data. This is not considered significant for the purposes of this project, however, the source of the mismatch should be identified.
Electricity supply and sales information for the 12 months ended 2003 (Eskom)	Conventional vs prepaid Could also be disaggregated to the customer level if necessary	Eskom Menlyn Regional Office	Includes Large Power consumers. Consumption level per client is confidential for strategic reasons. The breakdown was not available by demand sector. The Eskom submission to NER is expected to provide this information. Average monthly consumption only was available for prepaid customers.
Data from CTMM's Electricity Department for 2003/2004 (actual) and 2004/2005 (projected)	Tariff levels	CTMM Electricity Department	Information submitted on a per tariff basis.
Liquid Fuels	Magisterial districts	SAPIA	The base data is of good quality and is valid for this application other than the small discrepancy with the data boundaries as described in Section 3.6.2. A small loss of quality occurs as a result of the assumptions in terms of allocating the use of specific fuels to specific sectors. This effect is considered minor.
Coal	Merchant	Coal Merchants and major collieries	Household coal consumption was derived through a survey of merchants' sales to other classes of consumers
Piped gas	Industrial sectors within CTMM	Sasol Gas	This data comes from one source and is used in one sector only. It is considered of good quality and fully valid. The names of individual consumers were not provided.
LPG	Provided by municipalities within CTMM	BP, Sasol Gas	Other major companies supplying CTMM did not provide any data for confidentiality reasons.
Renewable Energy and Energy Efficiency	Provincial	Eskom, Bonesa, TSI	There is not much data on RE and EE pertaining CTMM since few initiatives are undertaken. Industries are assumed to undertake their own EE initiatives, but this was difficult to collect.

DATA SET	LEVEL OF DISAGGREGATION	DATA SOURCE	COMMENTS
Environment and air quality – emissions	Johannesburg Metro/Gauteng	CTMM Air Quality Baseline Study	
Environment – health related	General – not disaggregated	World Health Organization, International Association for Research on Cancer, Cigré, EPRI	Studies have been conducted internationally and results can be applied generally in CTMM
Households	Ward (selected)	National Census, Household Energy Survey, Eskom household lighting survey (Ga-Rankuwa)	Apparent discrepancy in total number of households and in households having access to electricity – census figures appear excessive in comparison with CTMM billings. Survey has been administered in selected areas. Awaiting outcome of Eskom household lighting survey.
Transport – cars	Vehicle type/fuel type	Traffic counts and modelling	CTMM EMME/2 transportation model has been used to derive useful origin-destination matrices and vehicle-kilometre values in conjunction with Visum
Transport – rail		Intersite, Metrorail	
Transport – taxis	Municipalities	Taxi Associations	

3.6 STUDY CONSTRAINTS

The major constraints are the fact that the data is not readily available and that those that have to supply it have to spend some time in doing so. Liquid fuels and pipeline gas data was obtained relatively quickly indicating the use of an integrated database. In the case of electricity many persons had to be approached for different parts of the data. It was clear that an integrated database was not available and the data had to be extracted from a number of sources and spreadsheets. In the case of RE and EE data, not all information, particularly pertaining to CTMM, was readily available.

3.6.1 Liquid fuels

- Liquid fuels data is collected on the basis of magisterial districts, a system that is no longer generally in use. It was initially difficult to identify the magisterial districts and these boundaries do not fully conform to those of CTMM. Data was collected for Pretoria, Ga-Rankuwa (note this is called Odi in the SAPIA database), Soshanguve and Wonderboom for each energy carrier, but could only be obtained for Pretoria in terms of marketing channels (used to derive consumption by demand sector).
- Interpretations are required as indicated in Section 3.1 in translating this liquid fuel data into the sectors of use.
- Sensitivity/business confidentiality relating to some data.
- No problems were experienced in obtaining pipeline gas data other than the total income from gas sales and by implication the negotiated tariff for large users.

3.6.2 Electricity

- Availability of data for a common period
- Difficulty reconciling distribution losses
- Unavailability of sectoral demand in Eskom-served areas (NER license submission required)

3.6.3 Environment and Air Quality

With respect to the environment and air quality the following specific constraints were experienced:

- Specific emissions for air quality data was unavailable;
- Ambient data for atmospheric emissions was unavailable;
- Quantification of GHGs and impacts from acid rain is difficult;
- Specific data for animal and plant health unavailable;
- Impacts of the agricultural sector minimal; and
- Impacts of and on biomass use are unclear.

3.7 DATA CHECKLIST

The checklist in Table 6 overleaf provides the listing of data required under the project terms of reference, as well as an indication of the method used to obtain the data. Data gaps and follow-up activities are also explained where relevant.

Table 6 Data Checklist

PARAMETER	METHOD OBTAINED/COMMENTS
Demand-side data requirements for the State of Energy Report	
Total demand of each energy source per sector.	Determined through Energy Balance.
Total demand of each energy source for CTMM.	Determined through Energy Balance.
Total emissions (local and global) for CTMM per energy source and per sector.	Through calculation based on the energy balance and vehicle transport modelling.
Statistics which provide a profile of CTMM area (population, households, economic indicators etc)	Collected through National Census, CTMM website and CTMM data sources
RESIDENTIAL:	
Total population	National Census and comparison with CTMM data; data not expected to be available for reference year, has required some adjustment to update to 2004/2005
Total households, broken down into (1) mid-hi income and (2) low-income	National Census and comparison with CTMM data; data not expected to be available for reference year, will require some adjustment
No Electrified households	CTMM Electricity Department, Eskom and NER
Typical average consumption (quantified) of each energy source for three categories of household – (1) mid-hi income, (2) low-income electrified and (3) low-income unelectrified: o Broken down (in quantity and proportion) intodifferent end-uses (lighting, cooking etc),and by type of appliance (e.g. gas ring or stove, paraffin primus or flame, elec hotplate or stove/oven, elec incandescent or CFL, light, etc).	Absolute data is not be available for the full CTMM population. Some data is available through the national census. Household surveys are assisting in developing a view on the proportion of energy used by carrier for each household category.

proportions of households using particular energy sources and appliances is to be given for the above categories, as far as this data is available.	
Average expenditure on energy, by source, for the above categories of household	Household surveys and supply side information will provide some information, but it is anticipated that some interpretation will be required.
Trends in electrification	NER has excellent data on these trends.
Trends in other fuel use	Reference has been made to the EMM State of Energy Report, DME website and CTMM Transport Department.
Any data/statistics which clarifies the health and environmental impact of energy use	Many qualitative assessments available, few quantitative assessments in the Highveld and fewer for Tshwane. Johannesburg Emissions Study provides data and discussions on health effects.
INDUSTRIAL	
Number of different industries, broken down into standard categories (mining, food & beverages, pulp & paper, etc).	Aggregated for purposes of preliminary analysis
Total consumption per energy source for sector	Determined through the Energy Balance
Average consumption of different industry categories (quantified by energy source)	Determined through data from suppliers; some interpretation may be required as liquid fuels database categories do not match the National Energy Balance categories.
Proportions of industries using different energy sources with categories.	Data aggregated at this stage
COMMERCIAL	
Number of commercial users	Reasonably accurate data for number of electricity consumers is available, however, no breakdown is available for commercial liquid fuel customers.
Average energy source profile (in a few different sub-categories where users differ greatly in characteristics): broken down (in quantity) into different end uses (HVAC, lighting etc) and type of appliance (fluorescent, CFL, incandescent lighting, etc) as far as possible.	Hard data is not available in this category. While DME has done extensive work in commercial building energy use, information is not available specifically for Tshwane commercial consumers. It is recommended this component be the subject of a dedicated survey outside the scope of this project.

○ proportions of users using particular energy sources and appliances is to be given, as far as this data is available.	
Average expenditure on energy source, by source, per user (or user sub-category)	Being assessed through survey and comparison with available data; accuracy is limited.
GOVERNMENT	
(Note: integrated data already collected on local government, and include government transport in the below data)	The Internal Energy Audit will be used as a basis for analysis at the next stage. However, the scope and accuracy of the results of this audit are not known, so the Team cannot confirm the integration of these results into project activities until the study has been reviewed.
Number of government users	A list of National, Provincial and Local Government offices and facilities in CTMM will be drawn up through consultation with the CTMM Electricity Department. The list will include addresses and typical monthly electricity consumption.
Average energy source profile (in a few different sub-categories where users differ greatly in characteristics): ○ broken down (in quantity) into different end uses (HVAC, lighting etc) and type of appliance (fluorescent, CFL, incandescent lighting, etc) as far as possible. ○ proportions of users using particular energy sources and appliances is to be given, as far as this data is available.	Government facilities typically consume liquid fuels and electricity, and neither data set is readily available at the disaggregated level. Under the Public Finance Management Act (PFMA), government departments are responsible for reporting their costs through single point accounting, meaning that electricity and fuel purchases are accounted for through the relevant department, not the facility itself.
Average expenditure on energy source, by source, per user (or user sub-category)	This data has not yet been assessed.
TRANSPORT	
No. Vehicles (broken down into petrol, diesel, other)	This data was approximated through a combination of application of the Tshwane EMME2 model and selected field surveys.
Vehicle-km (or passenger-km for passenger transport)	
Modal splits for passenger transport, in division of rail/bus/taxi/private.	
No. Freight vehicles, and average freight ton-km	

Energy used by each transport mode, quantified by energy source.	The data has been collected from liquid fuels and electricity suppliers. It has not been possible to disaggregate the data by transport mode and energy carrier.
Emissions (global and local) from energy sources (per unit as well as total)	These will be approximated through application of the appropriate emissions coefficients (in tons CO_2/GJ, as provided by the international standard of the IPCC Guidelines for National Greenhouse Gas Inventories) with respect to specific energy carriers. Emissions coefficients have been locally determined by Eskom and the mining industry (for coal). We have incorporated these modifications in our analysis.
Trends in vehicle types, energy demand and modal splits	These have been evaluated through the Team's experience in transportation modelling.
ELECTRICITY SUPPLY	
Total supply	Total supply to CTMM has been quantified in MWh. A list of electricity generation sources, including IPPs (none), has been developed. Bulk supply from Eskom to CTMM has been quantified in collaboration with the Tshwane Electricity Department.
Supply sources	Supply sources have been identified.
Details of local generation plant characteristics.	Local generation plant has been described in terms of number and type of units, fuel and lubricants used, unit ratings, feeders and plant location.
Cost of different sources	These have been assessed in collaboration with the Tshwane Electricity Department and Plant Management.
Emissions from different sources	Emissions will be quantified in terms of the fuel used to generate the electricity.
Trends in total supply	This has been evaluated through the Team's energy sector experience and NER perspectives.
LIQUID FUELS (including natural/piped gas)	Gas and LPG have been disaggregated from other liquid fuels due to its specific consumer base and unique pricing systems. Our approach has been to present data as Transport Liquid Fuels (Diesel, Petrol) and Stationary Liquid Fuels (LPG, IP)

Total supply per fuel type	This information is readily available from SAPIA by magisterial district.
Supply sources	SAPIA's database indicates quantity of liquid fuel (disaggregated by type) sold by marketing channel (i.e. filling stations, other resellers, coops, etc.)
Details of supply plant characteristics (capacity, quantities, emissions, growth potential, etc).	This assessment has been carried out based on the Team's energy sector experience.
Cost of supply of different sources	From SAPIA's database and DME fuel price regulations
Emissions from different sources	Emissions will be quantified in terms of the specific liquid fuel and quantity burned in the reference year.
Trends in total supply	This assessment has been carried out based on the Team's energy sector experience.

4. ENERGY BALANCE

An energy balance was carried out to assess the fundamental movement of energy through its main carriers through CTMM.

4.1 ENERGY BALANCE IN PHYSICAL TERMS

All of the available energy supply and demand data was incorporated into the energy balance using the format adopted by the International Energy Agency (IEA). The level of disaggregation has been reduced, as the source data does not support a detailed disaggregation. A number of interpretations or assumptions were made on the liquid fuel raw data in this process, mainly:

- Liquid fuels sold by the “other commercial” marketing channel are taken as industrial use, other than petrol where the split is taken as 50% industry and 50% commerce.
- IP sold by service stations and resellers is taken as use by households.
- LPG sold by service stations and other resellers is taken as 50% household and 50% commerce.

The results of the preliminary energy balance in physical units are presented in Table 4 below.

Table 7 Energy balance for CTMM in physical units, 2004

Fuel Type	Petrol	Diesel	Jet fuel	Avgas	Furnace oils	IP	LPG	Sasol gas	Electricity	Coal
Units	kl	kl	kl	kl	kl	kl	kl	GJ	MWh	tonnes
Primary Imports									985,980	
Secondary Imports	834,260	294,260	2,979	2,068	62,739	53,868	18,766	1,812,363	7,574,254	1,088,978.00
less aviation bunkers										
less losses									1,019,263	0
Secondary supply	**834,260**	**294,260**	**2,979**	**2,068**	**62,739**	**53,868**	**18,766**	**1,812,363**	**7,540,971**	**1,088,978**
Households						25,059	8,506		3,138,830	266,027
Industry/construction	55	15,472	0	0	0	1,220	0	1,812,363	3,364,416	822,951
Mining and quarrying	33	5,157	0	0	0	420	0		0	
Commerce	15,220	48,979	958	1,890	62,618	1,697	1,748		1,183,940	
Local Government	6,437	9,163	2,019	116	0	7	5		0	
Agriculture	271	6,163	2	0	121	401	0		142,448	
Transport	812,243	209,327	0	62	0	25,063	8,506		0	
Total final consumption	**834,260**	**294,260**	**2,979**	**2,068**	**62,739**	**53,868**	**18,766**	**1,812,363**	**7,829,634**	**1,088,978**

In accordance with the IEA methodology, international and national aviation and marine bunkers are only considered in the top part of the energy balance, as the energy is not consumed within the area that is being analysed.

Typical energy unit multipliers

kilo = 1 thousand	1 000	10^3	k
mega= 1 million	1 000 000	10^6	M
giga = 1 billion	1 000 000 000	10^9	G
tera = 1 trillion	1 000 000 000 000	10^{12}	T
peta = 1 thousand trillion		10^{15}	P

WHAT IS A JOULE?

A Joule is a unit of energy corresponding to 1 Watt-second or .0002777 Watt-hours, and a Gigajoule is a billion Joules. In terms of light bulbs, this means that a 60 W bulb burning for 1 hour would use 60 Watt-hours of energy, or 216 kilojoules (kJ) of energy, about the same amount of energy found in a 20 g handful of raisins.

4.2 CONVERSION FACTORS

In order to convert the energy balance in Table 4 into a common energy unit, a multiple of the Joule[3], conversion factors for each fuel are required. Conversion factors for the same fuel differ to some extent internationally due to different physical characteristics of crude and therefore the production of the specific fuel. Table 5 indicates local and representative conversion factors as published by the DME[4] in 1998.

Table 8 Energy conversion factors

Energy carrier	Units	Conversion factor	Energy carrier	Units	Conversion factor
Petrol	MJ/l	34.2	IP	MJ/l	37
Diesel	MJ/l	38.1	LPG	MJ/l	26.7
Jet fuel	MJ/l	34.3	Sasol gas	GJ	1
Avgas	MJ/l	33.9	Electricity	MJ/kWh	3.6
Furnace oil	MJ/l	39.9	Coal	MJ/kg	24.3

4.3 ENERGY BALANCE

The energy balance in energy units (gigajoules – GJ – Joules x 10^{12}) is given in Table 8 below. It has been simplified in comparison to the energy balance in physical units by grouping liquid fuels with similar use (transport/stationary) together.

Table 9 Energy balance for CTMM (2004)

Energy Balance 2005, GJ	Transport liquid fuels	Stationary type liquid fuels	Sasol gas	Electricity	Coal	Total	% of CTMM total
Primary Imports				3,549,529			
Secondary Imports	39,915,255	4,994,288	1,812,363	27,267,315	26,462,165.40	100,451,386	
less aviation bunkers						0	
less losses				3,669,347		3,669,347	13.5%
Total secondary energy supply	**39,915,255**	**4,994,288**	**1,812,363**	**28,186,683**	**26,462,165**	**101,370,754**	
Households	0	1,154,306	0	11,299,788	6,464,449	18,918,543	18.7%
Industry, construction	591,357	45,140	1,812,363	12,111,897	19,997,717	34,558,474	34.1%
Mining and quarrying	197,608	15,540	0	0	0	213,148	0.2%
Commerce	2,483,526	2,604,820	0	4,262,185	0	9,350,530	9.2%
Local Government	642,454	389	0	0	0	642,842	0.6%
Agriculture	244,150	19,649	0	512,813	0	776,611	0.8%
Transport	35,756,160	1,154,445	0	0	0	36,910,606	36.4%
Total, final use	**39,915,255**	**4,994,288**	**1,812,363**	**28,186,683**	**26,462,165**	**101,370,754**	**100%**
% of total use	39.4%	4.9%	1.8%	27.8%	26.1%	100.0%	

[4] DME, Digest of South African Energy Statistics, 1998.

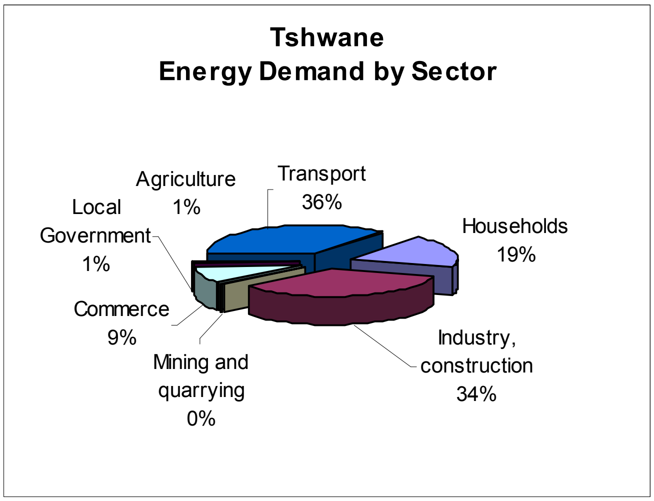
[4] Transport type liquid fuels- petrol, diesel, avgas and jet fuel. Stationary type liquid fuels: IP and LPG

4.4 CONCLUSIONS FROM ENERGY BALANCE

4.4.1 Energy Demand

The energy balance in Table 9 gives the total demand for energy in CTMM in 2004. This amounts to 101.4 PJ. The most significant consumption is in the transport sector (36%), followed by industry/construction (34%) and households (19%).

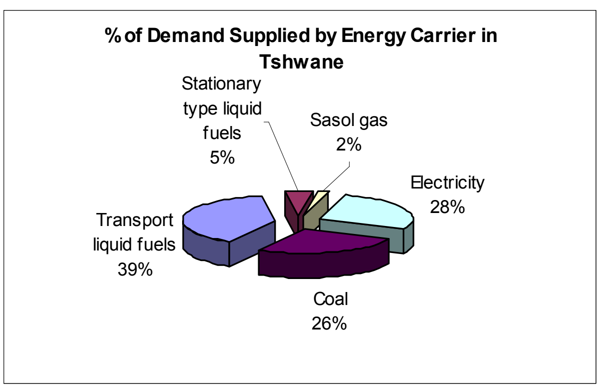
Figure 10 Tshwane Energy Demand by Sector (2004)



4.4.1.1 Energy Demand by Carrier

Linked to the distribution of sectoral energy use, liquid fuels supply most (44.3%) of the energy consumed in CTMM, followed by electricity with 27.8% and coal with 26.1%.

Figure 11 % of demand supplied by energy carrier in CTMM

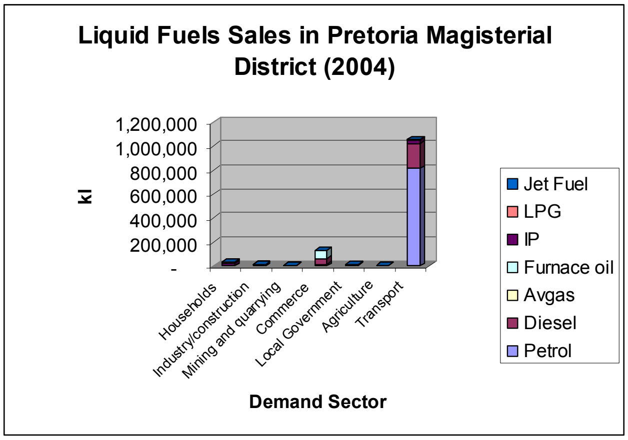


4.4.1.1.1 Demand by Carrier – Liquid Fuels (44.3%)

Liquid fuel consumption in CTMM was 1 386 263 kl in 2004, broken down by Magisterial District and fuel type as shown below. Data for all Tshwane was available by Magisterial District, but the more detailed records of supply by marketing channel are available only for Pretoria Magisterial District.

Transport liquid fuels (petrol, diesel) account for the majority of liquid fuel consumption in Tshwane, at 92%, while stationary liquid fuels (furnace oil, illuminating paraffin and LPG) account for the balance of 8%. LPG consumption is still proportionately very low at 1%. There are some apparent inconsistencies between LPG and jet fuel data between these two data sets. This is to be discussed with SAPIA.

Figure 12 Demand for liquid fuels

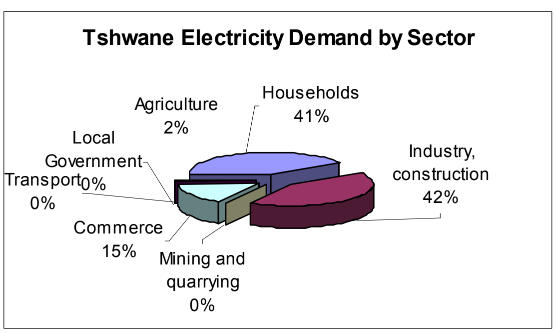


4.4.1.1.2 Demand by Carrier – Electricity Demand (27.8%)

Both CTMM and Eskom supply electricity within CTMM area, with Eskom supplying on average about 90% of Tshwane's electricity and the balance being supplied from Pretoria West and Rooiwal power stations within Tshwane. Tshwane Electricity purchased a total of 8 560 235 MWh from Eskom and the two power stations between July 2003 and June 2004.

During the period July 2003 to June 2004, Tshwane Electricity sold 7 648 571 MWh to 329 531 customers, while in the calendar year 2004 Eskom sold 181 061 MWh to its 2019 conventionally metered customers and about 152 kWh per month to some 57 500 prepaid meter customers, or 104 880 MWh, for a total of 285 941 MWh sold in that period. There was a total of 389 050 electricity customers in Tshwane in 2004.

Figure 13 CTMM electricity sales by demand sector



4.4.1.1.3 Demand by Carrier – Coal (26.1%)

Coal is consumed for power generation, industrial and household purposes within Tshwane. There are no collieries in Tshwane. Approximately 1,088,978 tonnes of coal are supplied in Tshwane annually. Coal addresses 57.9% of industrial demand (mainly to fuel steam boilers for industrial processes and laundry) and 34.2% of household demand.

4.4.1.1.4 *Demand by Carrier – Piped Gas (1.8%)*

Sasol supplies piped gas in CTMM to the industrial sectors. Households are not currently supplied with piped gas in CTMM. The Sasol pipelines that transported coal gas from Secunda to CTMM have been converted to transport natural gas and it is envisaged that residential areas may be reticulated to enable them to utilise natural gas.

Sasol supplied a total of 1 812 TJ to consumers in the metal, mining and non-metal, chemical, pulp and paper, manufacturing and food and commercial sectors in 2004. The largest consumer group for piped gas in CTMM is manufacturing, with 139 customers, generally small consumers. In terms of both demand and average use per customer, "Mining and non-metal" is the most significant subsector at 39% of total demand and 167 TJ/year respectively.

4.4.1.2 Energy Demand by Sector

4.4.1.2.1 *Demand by Sector – Transport (36.4%)*

The consumption of liquid fuels in CTMM was 44 849 TJ in 2004. Nationally, road transport accounts for 85% of the energy demand for the sector, which essentially draws on liquid fuels.

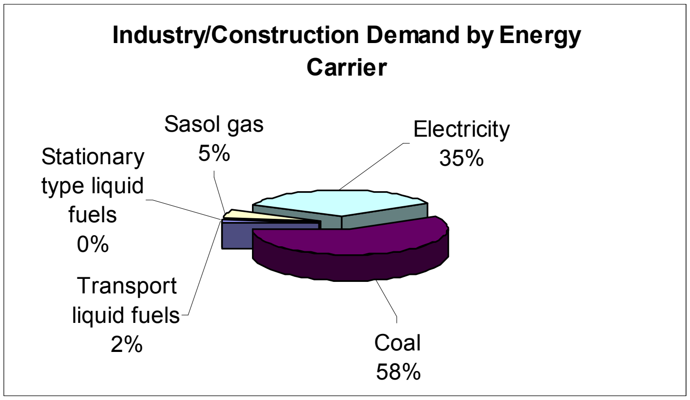
Figure 14 Typical Taxi Rank

Other demand components include international air transport, local air transport, rail and pipeline. The energy demand in these subsectors in CTMM is negligible. However, there are some inconsistencies in the data for jet fuel which merit closer examination.

4.4.1.2.2 *Demand by Sector – Industry (34.1%)*

Industry and construction consumed 34 513 TJ, supplied mainly by coal and electricity as shown below.

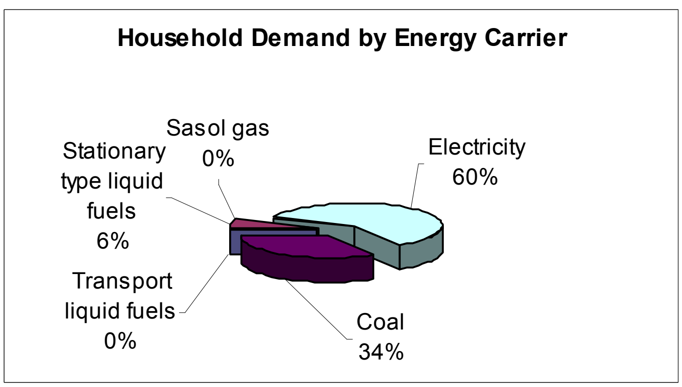
Figure 15 Industry/Construction Demand by Energy Carrier



4.4.1.2.3 Demand by Sector – Households (18.7%)

Households display a complex multiple fuel use pattern in serving their energy needs. Electricity is the most used energy carrier in households in CTMM. Lighting and TV/radio are the two main applications for electricity even when more traditional fuels are used for cooking and heating. Electricity, illuminating paraffin (IP) and coal dominate heating and cooking in CTMM.

Figure 16 CTMM household energy use by carrier (%)



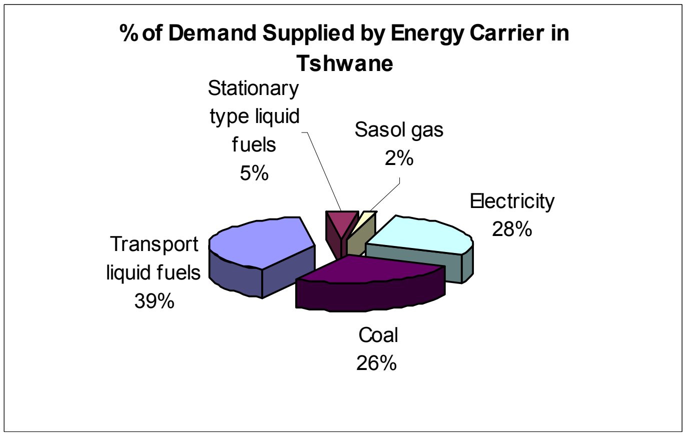
Energy usage characteristics in households tend to correlate with income levels. Thus, modest use of woodfuel, coal and IP corresponds to the lower income wards with more intensive use of electricity and transportation fuels correlating with the wards with higher income levels.

The subsidy put on IP by the Government through exemption from VAT encourages its use by households with relatively low incomes. A strategy is being developed by the Department of Minerals and Energy (DME) to roll out LPG, and it is envisaged that municipalities will play a key role in implementing the LPG strategy. Of the approximately 1 088 980 tonnes of coal consumed in CTMM annually, it is estimated that some 266 030 tonnes or 24% are consumed by households.

4.4.2 Energy Supply

Figure 17 shows CTMM's energy supply by carrier. Diesel and petrol combined ("transport" liquid fuels) provide the bulk of energy supplied in Tshwane (39%), followed by electricity (28%) and coal (26%). Stationary type liquid fuels (LPG, IP) and Sasol gas together represent less than 10% of energy supplied in the Metro.

Figure 17 Tshwane Energy Supply by Carrier (2004)

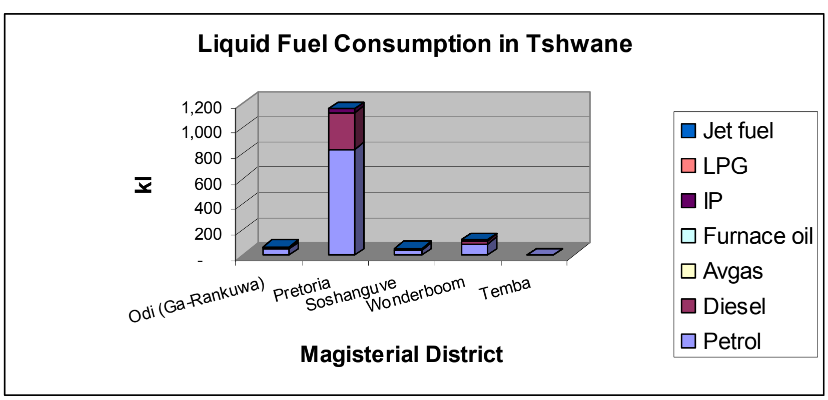


4.4.2.1.1 Supply by Energy Carrier – Liquid Fuels (44.3%)

The most important marketing channel for liquid fuels is through service stations (71% of total sales), followed by "other resellers" and "other commercial", each at 11%.

Recently, campaigns have been mounted to improve the safe use of paraffin by the Paraffin Safety Association. The DME is promoting LPG and other low-smoke fuels (coal) in order to minimise the use of paraffin mainly for safety reasons. There are plans to accelerate the use of LPG in the residential sector, particularly in low income households in order to reduce the use of dangerous IP. The South African government plans to supply clean petrol and diesel from 2006. The national government regulates the retail price of petrol, diesel and IP, calculating them through an import parity pricing formula called the Basic Fuel Price. VAT is not applied to paraffin sales, although the impact of this effective subsidy to the intended beneficiaries is under question. Retail pricing for LPG remains unregulated, and the question of whether zero-rating LPG for VAT would benefit poor consumers is being considered.

Figure 18 Supply of liquid fuels in CTMM, 2004



4.4.2.1.2 Supply by Energy Carrier – Electricity (27.8%)

CTMM has historically purchased about 90% of its electricity from Eskom, with the balance being supplied by Rooiwal and Pretoria West power stations located within CTMM. Total CTMM purchases from Eskom and these stations in 2004 amounted to 8 560 GWh, or 30.8 PJ. Losses (technical and non-technical), estimated from actual loss records provided by CTMM and an estimate of 5% on supply by Eskom Northern Region, total 1.3%. It is believed that this figure is low, and will be further investigated with CTMM staff.

4.4.2.1.3 Supply by Energy Carrier – Coal (26.1%)

Coal is consumed for power generation, industrial and household purposes within Tshwane. There are no collieries in Tshwane. Approximately 1,088,978 tonnes of coal are supplied in Tshwane annually. Coal addresses 57.9% of industrial demand (mainly to fuel steam boilers for industrial processes and laundry) and 34.2% of household demand.

4.4.2.1.4 Supply by Energy Carrier – Piped Gas (1.8%)

Sasol supplies 1.8 PJ via piped gas delivered at three depots, Babelegi, Rosslyn and Pretoria West. This is taken up exclusively by industrial consumers. The consumption of gas is expected to rise, with a commensurate drop in coal consumption as energy users engage in fuel switching. Gas is priced on a market value pricing mechanism under 400 TJ per annum consumption. For customers purchasing more than 400 TJ per year, prices are negotiated.

5. ENERGY DEMAND

This section first presents a profile of energy users by demand sector (household, industry/construction, mining and quarrying, commerce, local government, agriculture and transport), and then energy demand by carrier (liquid fuels, piped gas, electricity and coal).

5.1 BY ENERGY USERS

5.1.1 Household profile

According to the national census, there were 568 641 households in Tshwane in 2001. The pattern of households, as of 2004, was still characterized by a smaller, largely white suburban component occupying cores to the south within larger, largely black peri-urban and rural settlements arranged on the historical township model to the north, east and west.

Figure 19 Typical Urban Housing Arrangement – North Tshwane

Figure 20 Typical Peri-Urban Housing in Tshwane

Administratively, Tshwane is arranged on a ward basis. The Metro consists of 76 wards, as illustrated in Figure 21 below, which also shows the distribution of formal and informal housing. It is important to note that in terms of the Town planning and Townships Ordinance (ref Section 2.7), electricity services can only be delivered to formal housing, i.e. housing on land which has been proclaimed and which is the subject of a town planning scheme. Therefore, areas with high levels of informal housing have low electrification levels and other energy carriers are used instead of electricity for heating, lighting and cooking.

Figure 21 Dwelling Type

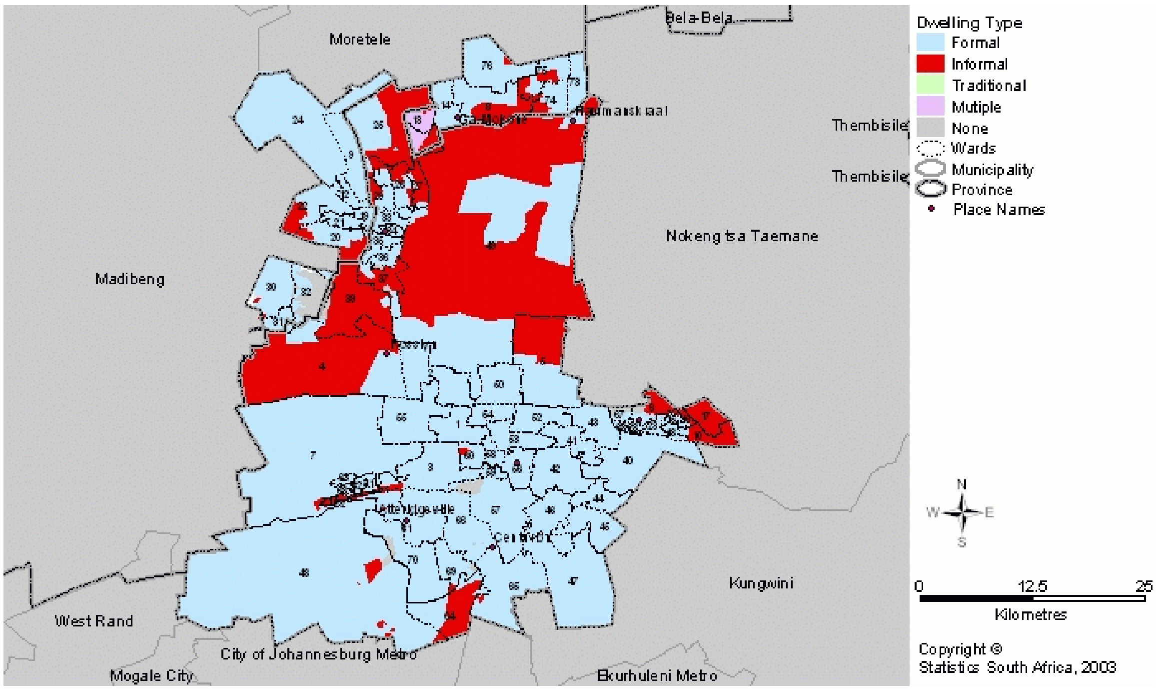


Figure 22 Population density in Tshwane

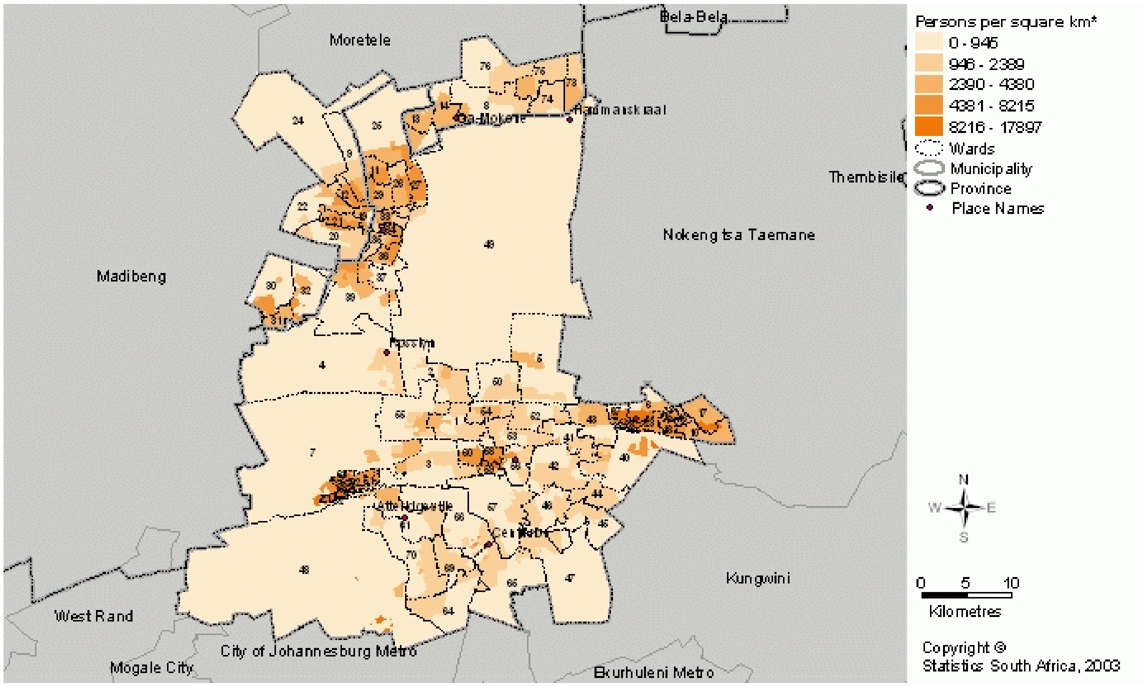
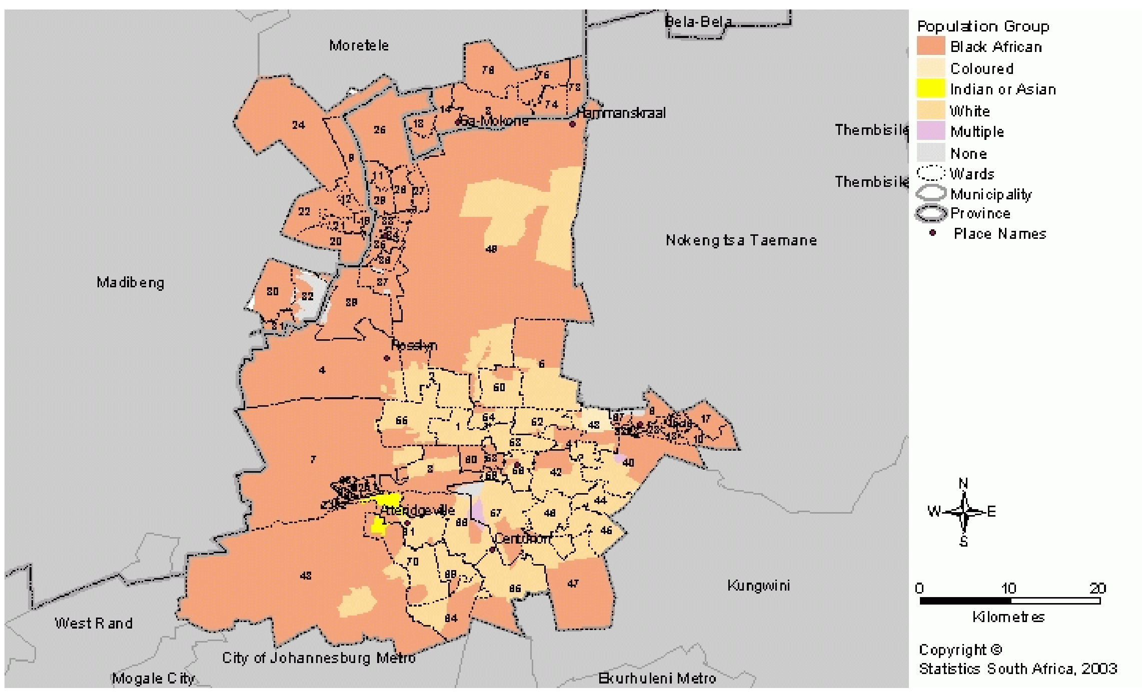


Figure 23 Distribution of population groups in Tshwane



Like households in the rest of South Africa, these households tend towards a complex multiple fuel use pattern to serve their energy needs:

- space heating
- water heating

- air conditioning
- appliance use, including
- cooking
- refrigeration
- lighting
- power tool use
- electronic news/entertainment media

The Energy White Paper (1998) makes several key points about household demand:

- energy services for low-income households have historically been inadequate
- households suffering unemployment and poverty rely on less convenient and often unhealthy fuels
- grid electrification may not satisfy the energy needs of low-income households
- most household energy consumers are women
- energy conservation by high-income households was not historically a policy priority
- coal use in urban areas results in indoor air pollution
- energy security for low-income households can help reduce poverty, increase livelihoods and improve living standards.

5.1.1.1 Income Profile of Tshwane Households

The national census provides profiles on a ward basis of households by income bracket. For illustrative purposes, we have selected Ward 1 (central-north area of Pretoria) and Ward 24 (northwest extremity of Tshwane) to illustrate the variety of residents and range of income profiles, as shown in Figure 244 and Table 10 overleaf.

Figure 24 Racial Profiles of Selected Wards

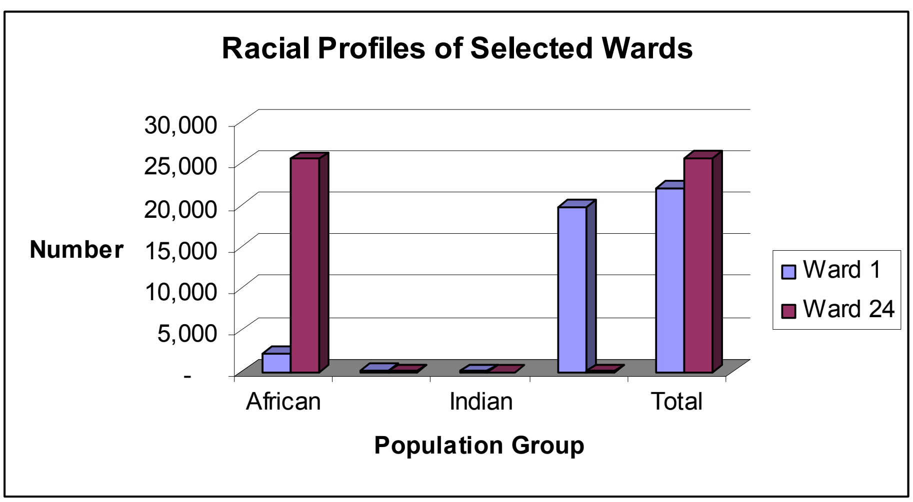


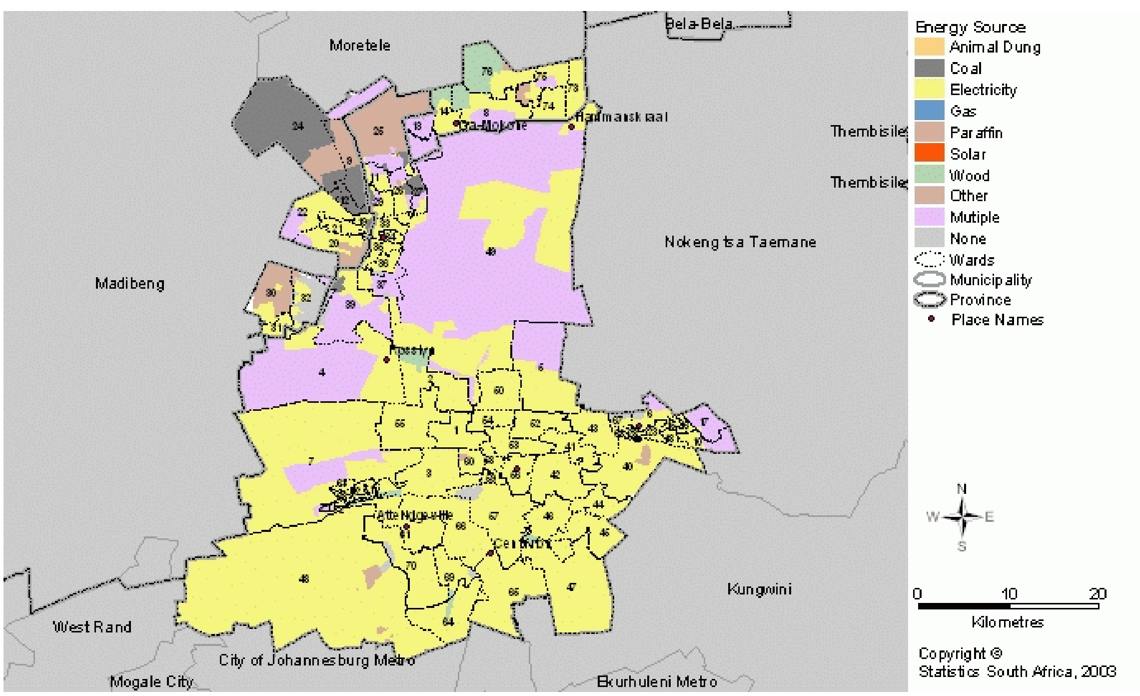
Table 10 Income Profile Comparison – Ward 1 and Ward 24

Individual Monthly Income (2001)	Ward 1	Ward 24
None	9 063	19 443
R1-400	477	1 044
R401-800	1 575	2 745
R801-1 600	1 902	1 410
R1 601-3 200	2 934	648
R3 201-6 400	3 468	132
R6 401-12 800	1 905	48
R12 801-25 600	408	12
R25 601-51 200	102	3
R51 201-102 400	60	3
R102 401-204 800	24	21
Over 204 801	9	0

Source: National Census, 2001

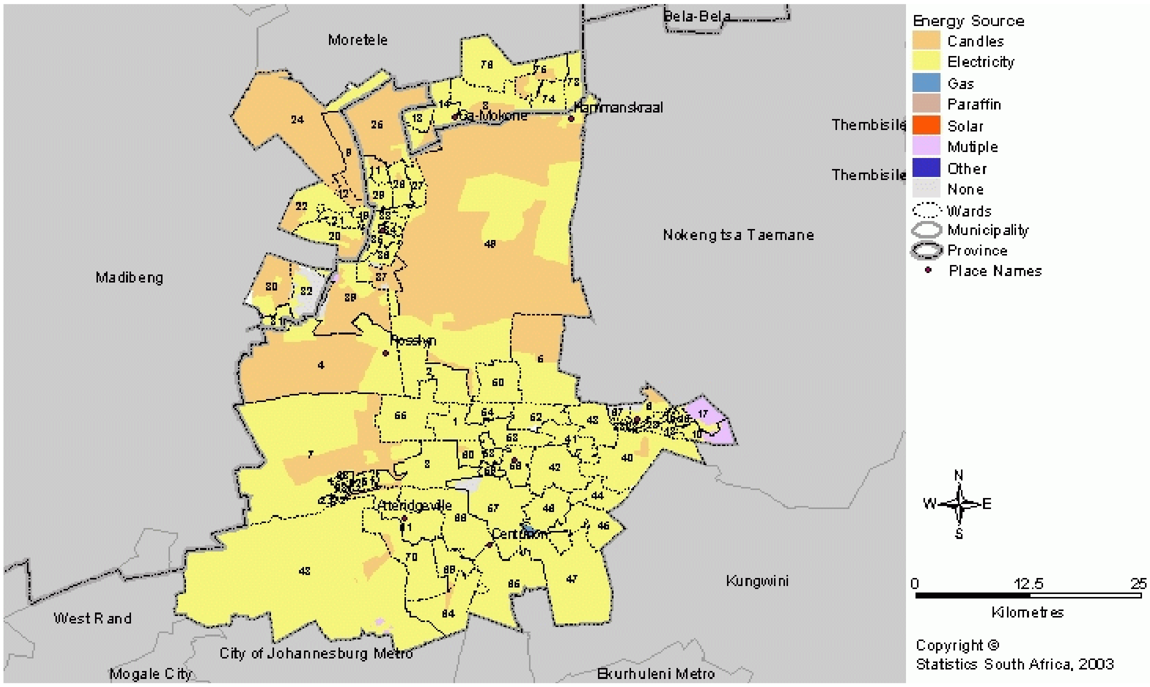
Such profiles are available for all 76 wards in Tshwane. It is not practical to reproduce them in this report. However, low-income levels correlate strongly with the use of alternative energy carriers (i.e. not electricity) for heating, lighting and cooking, as illustrated in Figures 25, 26 and 27.

Figure 25 Distribution of Energy Carriers for Heating



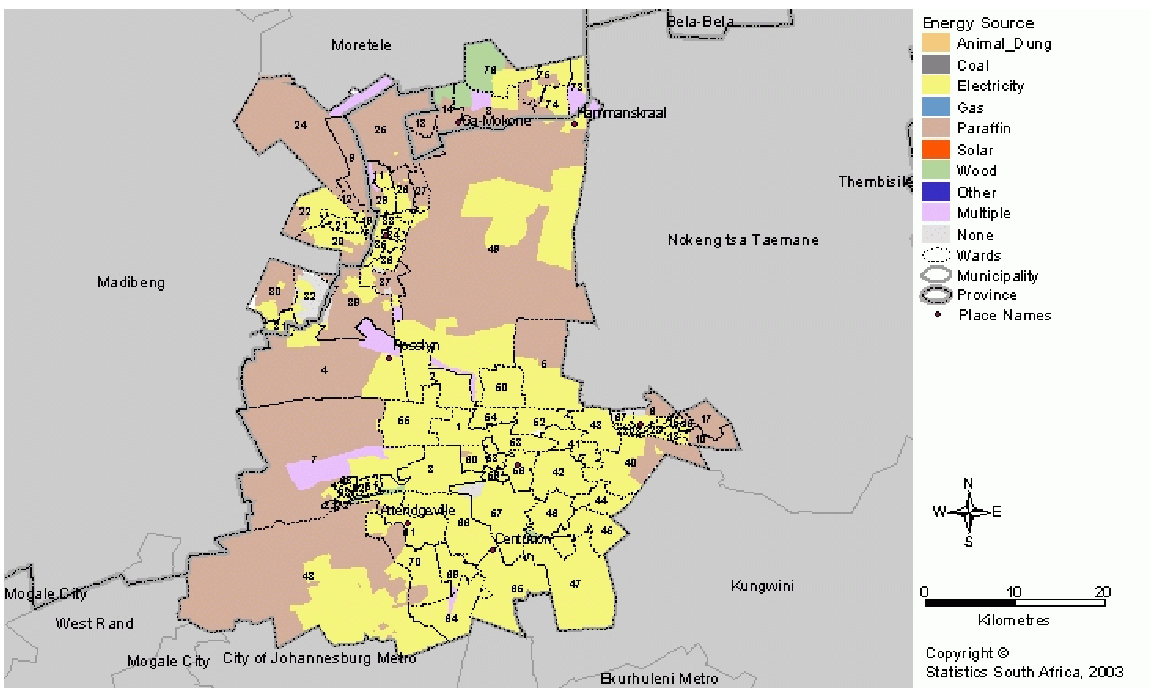
Source: SA National Census, 2001

Figure 26 Distribution of Energy Carriers for Lighting



Source: SA National Census, 2001

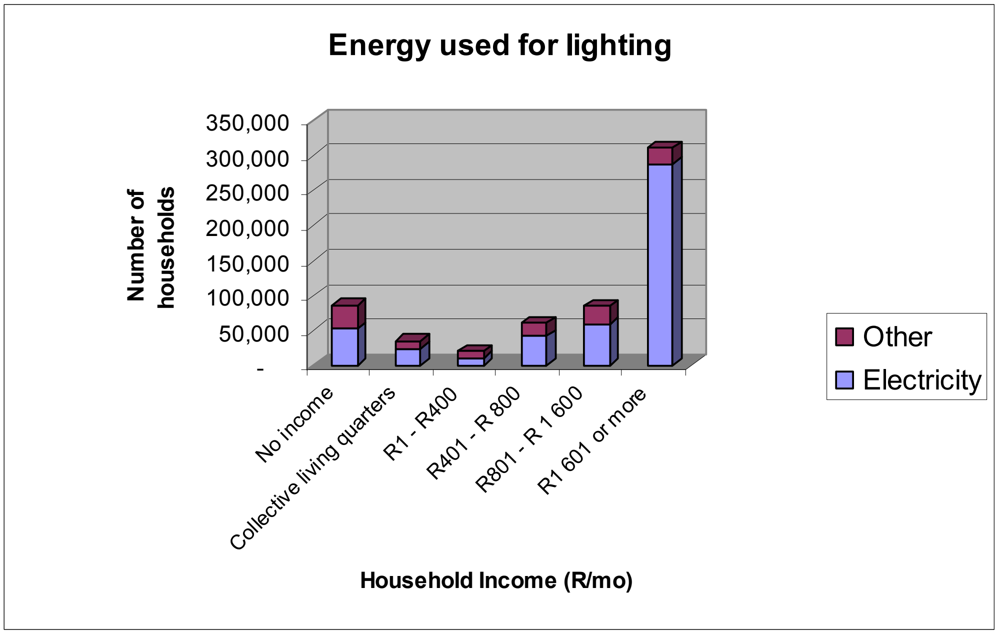
Figure 27 Distribution of Energy Carriers for Cooking



Source: SA National Census, 2001

To use lighting as an example, it is clear that there is a lower cut-off point of about R1600/month at which the use of electricity becomes available/affordable, as illustrated in Figure 28 overleaf.

Figure 28 Energy Used for Lighting in Tshwane



Source: SA National Census, 2001

The residential sector represents about 17% of energy consumption nationally.

5.1.2 Industry/Construction

Industrial energy consumers in Tshwane use a combination of electricity, coal and piped gas. Some 20 industrial consumers purchase more than 10 GWh per year from Tshwane's Electricity Department, with one further industrial consumer purchasing in the 1-10 GWh range. It was not possible to disaggregate the number of industries using coal or piped gas, although through an informal survey it was determined that at least three large industries use significant tonnages of coal. Industrial development has been concentrated in the Rosslyn and Pretoria West areas.

The industrial sector represents about 41% of total energy consumption in South Africa.

5.1.3 Mining and Quarrying

There are no mines, and only a few quarries, within the Tshwane boundary. These quarries mainly use diesel to power crushers and other electromechanical equipment, although one quarry does use electricity for aggregate preparation. The quarries are mainly located to the central northeast.

The mining sector represents about 6% of total energy consumption in South Africa.

5.1.4 Commerce

The commercial sector in Tshwane is extremely diverse, providing a wide range of goods and services over the entire jurisdiction of Tshwane and varying from small spaza shops and strip malls scattered throughout the Metro to large commercial malls in the central southeast (Menlyn, Brooklyn) and along Zambezi Road to the north (Kolonnade).

While data is not readily available for the preparation of a detailed profile of this demand sector, it has nevertheless been possible to characterise the sector in broad terms.

Like industrial consumers, commercial energy consumers in Tshwane also use a combination of electricity, coal and piped gas. A total of 33 commercial consumers purchase more than 10 GWh per year from Tshwane. Four more commercial consumers purchase electricity in the 1-10 GWh range.

Commercial developments such as Menlyn and Brooklyn shopping centres represent interesting energy efficiency opportunities, as significant savings may be derived following building energy audits. The commercial sector currently represents about 4% of energy consumption in South Africa.

5.1.5 Local Government

Most local government energy use is concentrated on electricity, liquid fuels (for fleet operation) and coal (mainly at school hostels and dormitories). Local government offices and facilities represent about 3% of total energy consumption in South Africa. The following is summarised from the Energy Baseline Study carried out for Tshwane in early 2005[5]:

Table 11 Local Government Energy Consumption

Demand Sub-Sector	Energy Consumed (f/y 2003/04)	
	Physical Units	GJ
Buildings	48 265 MWh	173 754
Transportation - diesel	12 058 kl	459 393
Transportation - petrol	2 499 kl	85 450
Traffic lighting	1 296 MWh	4 666
Street lighting	79 573 MWh	286 463
Water and sewage - electricity	47 684 MWh	171 662
Water and sewage - diesel	48.2 kl	1 650
Waste	-	-
Power stations – electricity	81 410 MWh	293 076
Power stations – coal	52 500 tons	1 275 750
Power stations - oil	105 kl	4 184
	Total	2 756 048

This represents about 2.7% of the total energy consumption in Tshwane, slightly lower than the national average.

5.1.6 Agriculture

The northeast of Tshwane, most of Wonderboom, is essentially agricultural land. There is also intensive, but limited, agricultural activity along the Apies River. This sector mainly

[5] Energy Baseline Report, Nyathi Energy Service Consultants (Pty) Ltd, 31 January 2005

consumes energy in the form of electricity and liquid fuels, both for transport and stationary purposes.

In addition to the more traditional semi-rural and rural agriculture practiced in the north of Tshwane, urban food production is becoming a new coping strategy for urban residents who have historically relied on produce from rural areas. Urban agriculture is defined as the production of vegetables, crops and small livestock by urban households for household consumption or for the urban market, and can include horticulture, forestry, aquaculture, floriculture and livestock production. Typically such practices take place on the fringes of the city. In Tshwane it is an accepted land use and its promotion is considered a Local Economic Development (LED) strategy.

CTMM has facilitated some urban agricultural (UA) initiatives, particularly in the Mabopane and Atteridgeville areas. Most of these activities are of low energy intensity and tend to be more labour intensive, with the net result of minimising capital expenditure on equipment such as pumps and tractors.

It should be noted that farmers typically mix IP with diesel in order to benefit from the VAT rebate on IP. This was not the intention of the subsidy.

Nationally, agriculture represents about 3% of total energy consumption.

5.1.7 Transport

The transport sector in Tshwane is also extremely diverse, comprising road transport (cars, light utility vehicles, minibus-taxis, buses and heavy trucks), rail links and air transport. Main road links in Tshwane are shown in Figure 31. Tshwane also has several civilian and military airports.

Figure 29 North-South Road Linkage

The status quo of transport, as well as the transportation planning and budgeting for the City of Tshwane, is described in the Integrated Transport Plan (2004/5 to 2009/10). This document includes a public transport plan, budgeting for infrastructure upgrades and a description of the transportation strategies for the City region.

There are several major transport-related projects in the region, each affecting the movement and accessibility to development in the area:

- N4 Platinum Highway
  - This freeway system to the north and west of the City facilitates development at the major motor-industry nodes and movement towards the North-West Province.
- Taxi Recapitalisation Programme
  - This ambitious project seeks to provide saver, better-regulated and more efficient public transport by means of the taxi industry.
- Mabopane Centurion Development Corridor (MCDC)
  - This project includes the construction of the PWV9 in the western region of the City, and will facilitate development from Mabopane in the northwest to Centurion in the south.
- Gautrain

There are two Gautrain stations planned for the City of Tshwane: Hatfield and Central Pretoria. It is envisaged that the Gautrain will alleviate a large proportion of the commuter traffic between Tshwane and Johannesburg/Midrand to the south during the peak hours.

Transport represents about 28% of total energy consumption nationally.

Figure 30 Commuters waiting at a train station

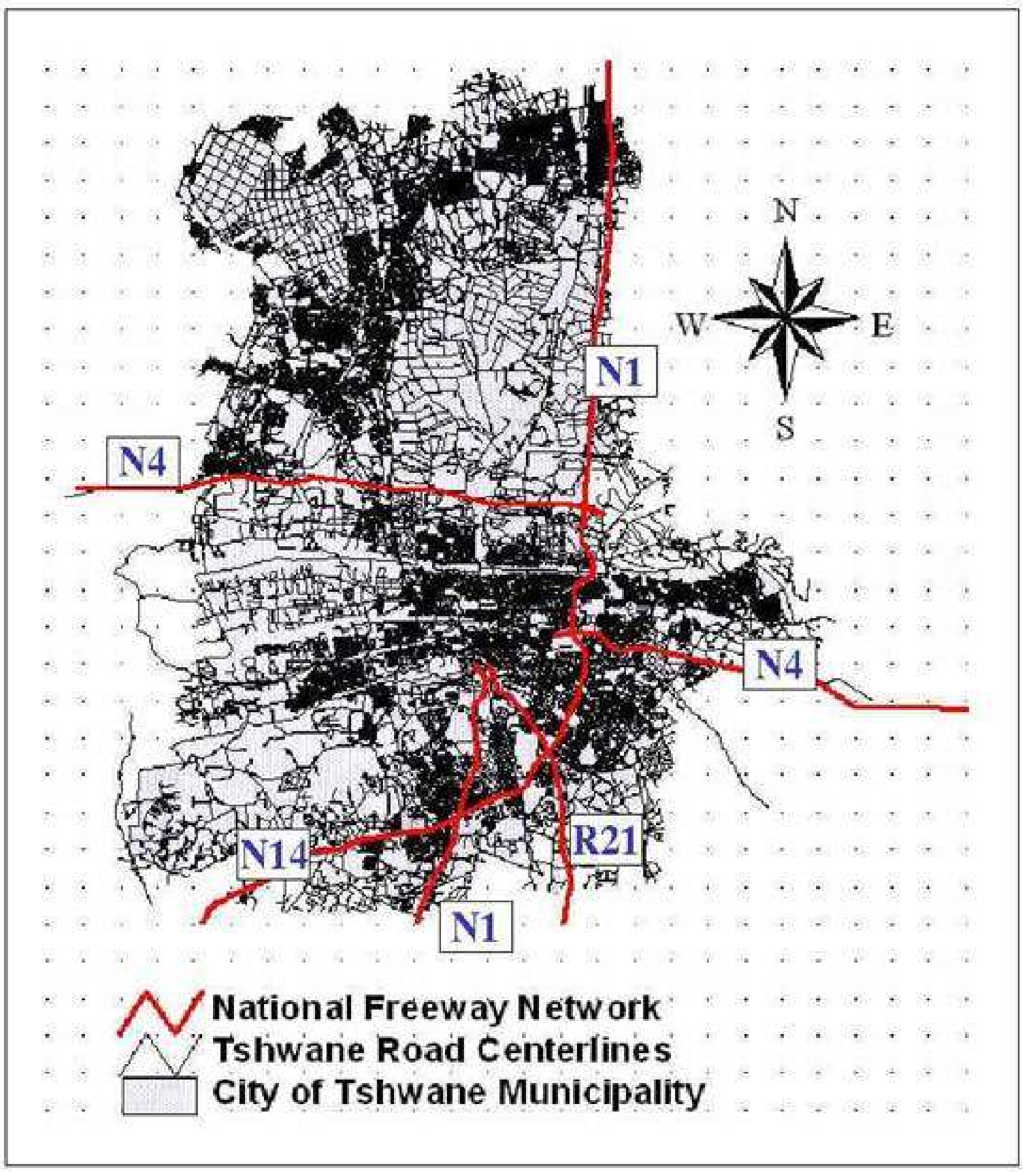
5.1.7.1 Road Network

There are good road and rail linkages in Tshwane. The N1, N4, N14 and R21 provide for long-distance movement within and beyond the CTMM, as shown in Figure 31. Congestion on these freeways is increasing, with volumes of heavy freight vehicles ever-increasing on both freeway and local roads in the network.

Tshwane has some 7 282 km of roads[6] (lane-kilometres), of which 5 109 km are tarred and 2 173 km are gravel, and including 360 km of freeways. By and large the CTMM does not suffer from traffic congestion. Only 7.2 per cent of roads experience a level of service E and another 3.5 per cent level of service F (indicating a high level of congestion).

CTMM has the second highest length of freeway of South Africa's municipalities, 0.42 lane-kilometres per 1000 population compared with 0.29 in Johannesburg. Freeway and arterial road provision per square kilometre in CTMM is comparable with Johannesburg (0.37 lane-km/km^2 of freeway and 1.09 lane-km/km^2 of arterial road compared with 0.59 and 1.67 in Johannesburg). Considering the amount of vacant and rural land in the CTMM, the foregoing indicates good road provision in the CTMM with adequate spare capacity.

Figure 31 Tshwane Roads Network



[6] Only municipality-managed roads included.

The transport sector was the biggest consumer of energy in CTMM in 2004. In absolute terms this was 39.9 PJ and represented 39.4% of the total energy consumption in the municipality. The relatively high energy consumption is mainly due to the fact that residential areas are far removed from businesses, making commuting necessary.

5.1.7.2 Vehicular Transport

5.1.7.2.1 Field Surveys

Traffic counting on majority of arterials in the city was undertaken by Karabo Consulting (Pty) Ltd in March of 2004. The counted vehicles were divided into four classes of vehicles (cars, bus, taxi and truck). The counting stations are indicated on the accompanying drawing. The city was subdivided into 11 zones, as shown in Figure 32. The ingress and egress traffic for each zone is shown in Table 12.

The following conclusions can be drawn from the traffic surveys:

- Zone 5, which comprises the area bounded by the N1 to the east, Church Street to the north, Garstfontein Road to the south and the R55 to the west, has the highest inbound and outbound traffic in the peak period, followed by Tshwane CBD (Zone 11).
- Zone 7, which is located to the immediate south of Centurion business area, has the second lowest inbound and outbound traffic during the morning peak period. The phenomenon is expected to change in the medium term due to the residential, industrial and commercial rights and the expected development in that area.
- Zone 9, which is the extreme south-westerly area of Tshwane, has the lowest inbound and outbound traffic. This conforms to the type of land use found in the zone, which is mainly agricultural.

Figure 32 Zones Used for Traffic Counts

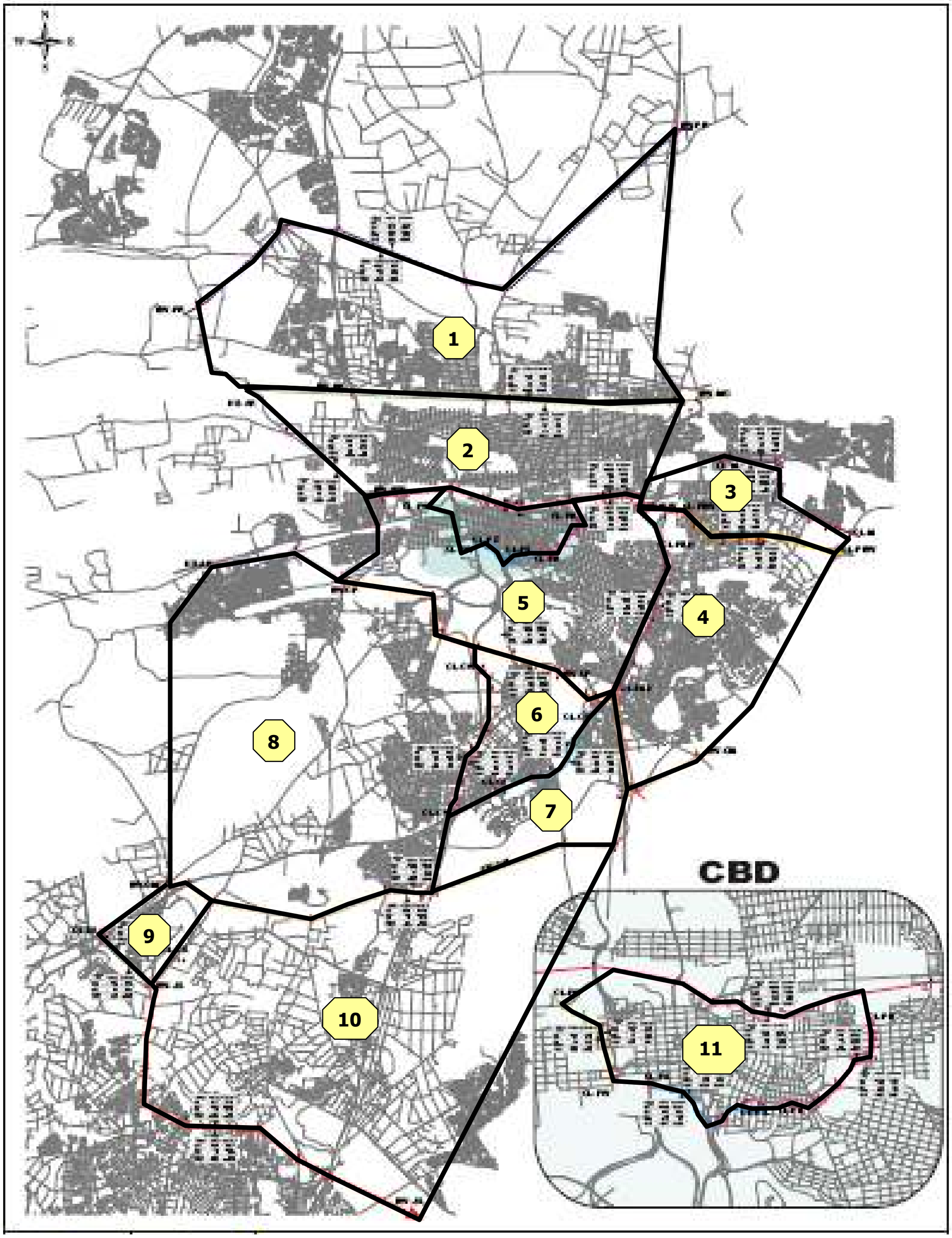


Table 12 Peak Hour Vehicular Volumes in Tshwane

Zone Boundary	PEAK HOUR VOLUME (veh/hr)						
	Zone Number	$LV^{(*)}_{In}$	$HV^{(**)}_{In}$	Total	LV_{Out}	HV_{Out}	Total
EW-PR to NS-AK 7 and EW-PR 7 to EW-MG 8	1	18,849	1,538	***20,387***	22,820	1,659	***24,479***
NS-AK to EW-WW and EW-MG 8 to EW-WW 10	2	33,649	2,342	***35,991***	49,269	2,409	***51,678***
CL-M 8 to CL-PEW 7 and CL-M 1 to EW-WW 10	3	10,035	629	***10,664***	7,717	633	***8,350***
EW-WW11 to EW-CP 11 and CL-PEW 7 to EW-CM 11	4	17,561	709	***18,270***	18,793	793	***19,586***
EW_WW 7 to EW-WW12 and CL-PEN 7 to EW-CP 1 to EW-WW 2 and 3	5	70,580	2,683	***73,263***	47,534	2,024	***49,558***
EW-CP 4 to CL-CW 6 to CL-CW 1 and CL-CS 1 to CL-CS 5 to EW-CP 9	6	12,187	666	***12,853***	28,540	1,194	***29,734***
CL-CW 1 to EW-CM 6 and EW-CP 10 to EW-CP 9 to CL-CS 5	7	4,745	206	***4,951***	5,877	323	***6,200***
NS-AK 2 to EW-CM 1 and EW-CP 4 to CL-CW 6 to CL-CW 1 to EW-CM 6	8	15,783	912	***16,695***	23,772	1,100	***24,872***
EW-CM 1 to CL-DS 1 and EW-JS 1 to EW-CM 3	9	3,117	222	***3,339***	2,842	202	***3,044***
EW-JS	10	18,166	1,166	***19,332***	21,191	1,249	***22,440***
EW-WW 3 to CL-PW 1 to CL-PW 5 to CL-PS 1 to CL-PS 6 to CL-PE 1 to CL-PE 9 to EW-WW 7	11	62,839	2,592	***65,431***	34,648	2,129	***36,777***

*: Light Vehicles; **: Heavy Vehicles

5.1.7.2.2 Determination of Vehicles using Petrol and Diesel in Tshwane

The total ingress and egress peak hour traffic was used to determine the Average Annual Daily Traffic (AADT) for each zone. Average Annual Daily Traffic (AADT) is defined as "the average number of vehicles per day on a particular road". AADT is a vehicle design flow parameter that was used to determine petrol and diesel usage in Tshwane.

The peak hour traffic volumes obtained from the traffic counts (refer to Table 1) were used to determine the ADT (Annual Daily Traffic) by multiplying the total number of vehicles over the peak period with an adjustment factor. The ADT is the average number of vehicles per day for one or more specific days of the year.

In turn the ADT was divided by an adjustment factor to determine the AADT. The adjustment factor was based on seasonal characteristics for arterial roads in an urban setup. The expected AADT is shown in Table 13 below.

Table 13 Average Annual Daily Traffic Volumes in Tshwane

Zone Number	AADT (veh/day)					
	LV_{In}	HV_{In}	Total	LV_{Out}	HV_{Out}	Total
1	158,262	12,914	**171,175**	271,786	19,759	**291,545**
2	282,527	19,664	**302,191**	586,794	28,691	**615,485**
3	84,257	5,281	**89,538**	91,909	7,539	**99,449**
4	147,448	5,953	**153,401**	223,825	9,445	**233,269**
5	592,611	22,527	**615,139**	566,130	24,106	**590,236**
6	102,326	5,592	**107,918**	339,911	14,221	**354,132**
7	39,840	1,730	**41,570**	69,995	3,847	**73,842**
8	132,519	7,657	**140,176**	283,125	13,101	**296,226**
9	26,171	1,864	**28,035**	33,848	2,406	**36,254**
10	152,527	9,790	**162,317**	252,385	14,876	**267,260**
11	527,615	21,763	**549,379**	412,658	25,356	**438,014**

The information shown in Table 13 was used to determine the number of vehicles using petrol and diesel in Tshwane. The National Association of Automobile Manufacturers of South Africa (NAAMSA) was consulted to determine the split of light vehicle sales nationwide over the past five years.

Table 14 Vehicle Sales during the 2000 – June 2005 Period

TYPE OF VEHICLE	NUMBER OF VEHICLE SALES PER YEAR (veh)					
	2000	2001	2002	2003	2004	Jan – Jun 2005
Diesel Cars & Light Commercials	50, 759	58, 740	65, 377	71, 318	81, 407	52, 006
Petrol Cars & Light Commercials	278, 598	295, 466	270, 972	280, 825	347, 373	198, 947
Total Cars & Light Commercials	329, 357	354, 206	336, 349	352, 143	428, 780	250, 953
Diesel Vehicles as %age of Total	15,4%	16,6%	19,4%	20,2%	19,0%	20,7%

Source: New Vehicles Sales analysis – Petrol vs Diesel Cars & LCV 2000 – 2004 – Jan-Jun 2005 (NAAMSA, June 2005)

Table 14 shows that in 2004 a total of 428 780 vehicles were sold in South Africa. Of these, 347 373 (81%) vehicles sold were petrol usage cars, whilst 81 407 (19%) were diesel usage cars. The 81:19 vehicle sale percentage split was used to determine the number of light vehicles using petrol and diesel.

Subsequent to that the light vehicles using diesel were added to heavy vehicles (HV) to make up the total number of vehicles using diesel in Tshwane. The average number of vehicles using petrol or diesel was multiplied by the number of days in the year to determine the total annual traffic volumes using petrol or diesel. The number of vehicles using petrol or diesel over a year is shown in Table 15 overleaf.

The total vehicle-kilometres during the AM peak hour period for CTMM (i.e. 2 578 594 veh-km) were separated into vehicle-kilometres per zone by using a weighting factor. The weighting factor was based on zone characteristics. The peak hour vehicle-kilometres were used to determine the average annual daily vehicle-kilometres by multiplying the vehicle-kilometres over the peak period for each zone with an adjustment factor.

The average annual daily vehicle-kilometres in each zone were further aggregated to show the total annual vehicle-kilometres by multiplying the average annual daily vehicle-kilometres by the number of days in the year. The average annual daily vehicle-kilometres as well as the total annual vehicle-kilometres per zone are shown inTable 16 on page 76.

Table 15 Total Annual Traffic Volumes in Tshwane

Zone Number	TOTAL ANNUAL TRAFFIC VOLUMES (veh/yr)			
	Petrol		Diesel	
	Ingress	Egress	Ingress	Egress
1	46,798,395	80,367,749	15,680,656	26,046,136
2	83,543,911	173,516,154	26,755,963	51,135,864
3	24,914,950	27,177,823	7,766,494	9,120,880
4	43,600,542	66,185,412	12,390,642	18,957,868
5	175,236,389	167,405,810	49,289,177	48,030,249
6	30,257,947	100,512,514	9,132,020	28,745,644
7	11,780,911	20,697,689	3,392,179	6,254,641
8	39,186,114	83,720,514	11,978,244	24,401,801
9	7,738,904	10,008,990	2,493,968	3,223,735
10	45,102,639	74,630,717	14,143,205	22,919,329
11	156,016,995	122,023,741	44,506,221	37,851,394

5.1.7.2.3 Bus transport

In Tshwane, buses are often perceived to be unreliable whilst walking is seen as unsafe.

Three types of subsidised bus operators currently operate inside the boundaries of the CTMM as follows:

1) Municipal operators

At present the CTMM is serviced by Pretoria City Transport (PCTs) with a bus fleet of an average age of about 20 years. The direct costs associated with the operation and management of PCTs are carried by subsidies from the CTMM.

There are problems experienced regarding the age of buses such as high maintenance costs, poor emission control due to older technology and standards used, and lower reliability. The present bus fleet requires a subsidy of about R33 150,00 per bus per month to break even. Urban public transport operations are generally not financially viable and financial support, usually in the form of subsidies, are required for continuing the delivery of the service. Public transport is a mobility option for those who are unable to afford private transport. Being a **social service** the subsidies are paid from public sources, that is, the income of government derived from taxes, levies, etc. paid by individuals and companies to the state.

Table 16 Vehicle-kilometres in CTMM

Zone Number	Vehicle-kilometres	
	Average Annual Daily (veh-km)	Total Annual (veh-km/annum)
1	218,027	79,579,966
2	389,220	142,065,164
3	116,075	42,367,497
4	203,129	74,142,065
5	816,402	297,986,842
6	140,968	51,453,183
7	54,886	20,033,261
8	182,563	66,635,397
9	36,054	13,159,889
10	210,127	76,696,358
11	726,862	265,304,550

Presently the financial shortfall of operating the bus service is largely financed by the community of the City of Tshwane, represented by the CTMM. The CTMM is currently in the process of establishing a municipal entity (as part of the Bus Rationalisation Plan) for the provision of the municipal bus service that is affordable, safe, reliable and effective for the residents of the CTMM. The entity is expected to supply a cost effective mechanical, electrical and structural repair and maintenance service to the bus service and will be able to tender for service contracts.

It is envisaged that the renewal of the bus fleet will improve the reliability of vehicles and reduce maintenance costs whilst improving the financial efficiency of the service, which could be beneficial to users. The subsidisation from the CTMM will continue, especially for social services (pensioners, etc).

Potential benefits sought by the CTMM include:

- Newer vehicles will be more fuel-efficient, produce less atmospheric pollution and will be less likely to lose fluids like engine oil;
- More attractive vehicles will serve as an incentive for more commuters to use the bus service;
- A reduction in the number of private vehicles on the road network, offering further benefits in terms of reduced noise pollution, reduced energy consumption and traffic congestion and extending the service life of the existing transport infrastructure.

2) Privately owned subsidised operators

The bus industry is currently dominated by month-to-month contracts. There are currently 34 interim bus contracts in the country that constitute about 67% of the total subsidy allocation of R2,28 billion.

In the CTMM there are now 12 registered learner transport operators, with in total of 34 buses. These have formed within the following sub-regional groups: Pretoria North, Erasmia, Mamelodi, Laudium, Pretoria West, Valhalla, Atteridgeville/Sausville and Haakdoring. Each has a local structure.

3) Private non-subsidised services

Bus transport in CTMM also includes privately owned, non-subsidised services such as Car Hires. These provide Shuttle services, particularly to and from the Johannesburg International Airport.

5.1.7.2.4 Minibus taxi transport

In Tshwane, minibus taxi services are considered unreliable and costly, with serious safety concerns. See Figure 33 for a typical minibus taxi.

The taxi industry is not subsidised, and is operated by private operators employing taxi drivers to drive their under-maintained and often un-roadworthy vehicles along routes that suffer from over-competition. Although taxi routes are licensed, enforcement suffers under a lack of regulation of the supply of services in any specific area.

Taxis transport as much as 60% of daily commuters, proving to be a much more attractive mode of transport than bus or rail, particularly outside of peak hours. Service is more flexible, and travelling speeds are faster. However, these advantages are often negated by security concerns, violence between operators and the danger of speeding, poorly maintained vehicles.

Figure 33 Typical Minibus Taxi

The Taxi Recapitalisation Programme, which aims to improve regulation and efficiency of the industry and to replace existing vehicles with newer, safer vehicles (see Figure 34 for an example of such a vehicle), is currently under investigation and the first phases are being implemented.

Figure 34 Proposed Improved Minibus-Taxi as part of Recapitalisation Programme

5.1.7.3 Rail transport

The CTMM has a good but under-utilised rail network. The commuter rail services are operated mainly on railway lines owned by the SA Rail Commuter Corporation (SARCC). In addition, commuter rail services extend to some sections of the Spoornet owned railway network. Metrorail, a business unit of Transnet Ltd., operates the commuter services in Gauteng.

The planned Gautrain services initiated by GAUTRANS and anticipated to be in service by 2010 are expected have a significant impact on the public transport between Tshwane and Johannesburg/Midrand in the south of Gauteng. However, under the current planning framework, the Gautrain will not reach the north of Tshwane. It is understood that consideration is being given to intermodal links (bus, rail) to transport systems in the north, however, at time of writing of this report the status of this planning had not been confirmed.

Furthermore, it is also understood that consideration is being given to the necessary intermodal links around planned Gautrain stations. These would include park and ride facilities, strengthening of the commercial (meter) taxi system, improved bus links and strengthening of security systems around stations to protect pedestrians and vehicles.

5.1.7.4 Airports

The Tshwane area includes the following airports:

- Waterkloof (private and government use)
- Wonderboom (private)
- Swartkops (Air Force base)

In terms of energy use, government/air force activities account for the bulk of jet fuel consumed within the municipality. It was not possible to assess a split between government/military and private use for avgas. To assess fuel consumption, in accordance with international convention, flights originating in CTMM but terminating outside the Metro area are deemed not to have taken place within the region, however, it was not possible to determine the quantity of fuel used for flights originating and terminating in CTMM for the analysis period. Given the negligible contribution of jet fuel to liquid fuel usage in Tshwane (ref Table 20), this is not considered pertinent to the analysis. However, if specific energy efficiency interventions are considered in the medium to long term in the aviation sector, a dedicated study should be commissioned to derive a clear picture of jet fuel and avgas usage at Tshwane airports.

5.1.7.5 Energy use

The modal split for liquid fuel use in the transport sector in South Africa is reflected in Table 17. Road transport is by far the major energy user as it accounts for 85% of the use of the total sector. Air transport (6% international, 5% local) and rail accounts for small percentages of the total use. These figures are not available for CTMM.

The second last line gives the use of transport energy in CTMM for 2005 for comparison purposes. Liquid fuel use in the transport sector amounted to about 6% of South Africa's total liquid fuel use in the transport sector in 2001 (latest date for which these figures are available). Electricity use in the sector is negligible. These relationships are not fully understood and have not been studied in depth.

Table 17 National and CTMM use of energy in the transport sector

Transport sector	Coal	Liquid fuels	Electricity	Total	% of total
South Africa, TJ (2001)					
International air transport		37 840		37 840	6%
Local air transport		28 978	133	29 111	5%
Road		525 978	79	526 057	85%
Rail	67	8 160	19 601[7]	27 828	4%
Pipeline			182	182	0%
Total	***67***	***600 956***	***19 995***	***621 018***	***100%***
% of total	0	97%	3%	100%	-
Tshwane, TJ (2004)					
CTMM total	***0***	***36 910***	***0***	***36 910***	***-***

[7] Includes 7067 TJ that is listed under "Transport non-specified".

5.1.7.6 *Energy efficiency in transport*

The efficient use of energy in transport is a complex topic that has not as yet received much attention in South Africa. The IEA inter alia reviews this topic and states "transport presents one of the biggest challenges to policy makers". It separately reviews passenger and freight transport as different conditions apply and indicates that cross-country comparisons and trends are in most cases not possible because of the different conditions.

The study indicates that a number of factors are of importance. These include:

- Structural, in the form distance travelled, quality and congestion of roads;

In the past there has been little integration between land use and transport planning in the Tshwane region;

- Availability, convenience and cost of public transport;
  - Poor and inconsistent public transport in Tshwane inhibits the use of more energy efficient modes.
- Vehicle characteristics, how they are used and fuel choice;
  - For example, a study in Gauteng found that once a household's income exceeds R3000 per month, a private car is purchased.
  - No congestion/road-user charging is applied, resulting in low perceived costs to the users of private vehicles.
- Cost and therefore the affordability of the different modes of transport, including where applicable capital and operating costs.

One of the elements that receives attention in the ITP document is Travel Demand Management (TDM), which is an essential component of an improved energy strategy for the transportation sector. TDM looks at controlling the demand on the network through integrated land use planning, shifts in modal choice toward higher occupancy vehicles through incentives, and staggered working hours. These measures are designed to decrease vehicular traffic during peak hours, reducing congestion, improving travel times and resulting in less energy being wasted and less emissions being produced.

In a later publication[8] the IEA states, "…trends in transport energy use and greenhouse gas emissions in IEA countries are currently on an unsustainable path… Most forecasts indicate that these trends are not likely to change significantly in the coming years without substantial new policy initiatives". Government policies have been and are used in most countries to modify some of these factors, in South Africa mainly the use of fuel taxes on liquid fuels. The DME's energy efficiency strategy[9] refers to fiscal policies (mainly the fee bate[10]), regulations/standards/codes of practice, public information programmes and programmes to change transport infrastructure (moving from road to rail) and the demand placed on it by users (spatial planning).

[8] IEA, Toward a Sustainable Energy Future, 2001, page 151.

[9] DME, Draft energy efficiency strategy for the RSA, April 2004.

[10] The license fee related to the fuel efficiency of the vehicle.

5.1.7.7 Gaps, constraints and issues

Extensive gaps exist on disaggregated data on transport energy use linked to the activity of that part of the transport sector. It is not possible to evaluate trends over time with the available information.

The major issue is to what extent the integration and coordination of the different transport systems that are taking place will address the issue of energy use and therefore the influence of air pollution and greenhouse emissions.

The regulation of emissions, monitored and enforced by means of regular and dependable testing, is a responsibility that needs to be taken up by the transportation sector in cooperation with the Environmental Health department.

5.2 ENERGY DEMAND BY CARRIER

In this section, the profiles of the demand for each of the energy carriers reviewed are outlined, and where appropriate, background is given on the characteristics of the specific energy carrier. The following are presented:

- Liquid fuels
- Piped gas
- Electricity
- Coal
- Biomass (animal dung, wood)

5.2.1 Liquid Fuels

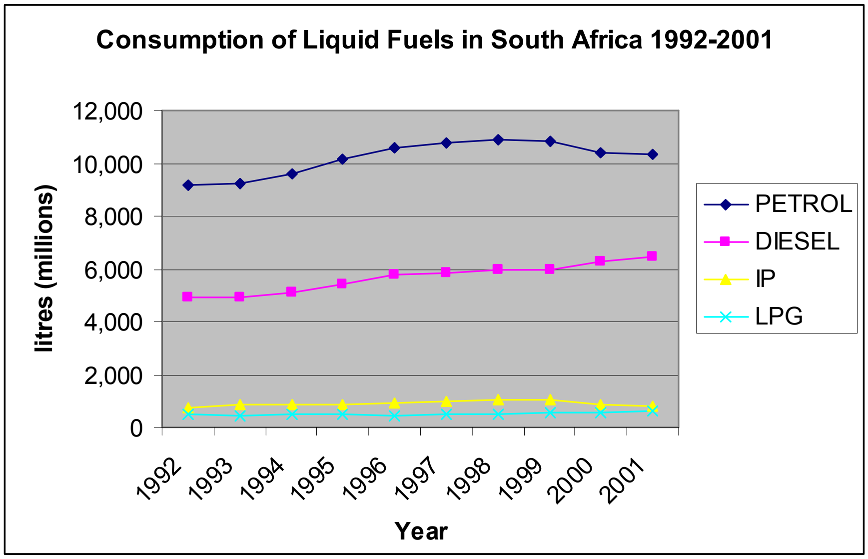
Liquid fuels consumed in South Africa include:

- Petrol
- Diesel
- Paraffin, also known as illuminating paraffin (IP)
- Jet fuel
- Fuel oil
- Liquefied petroleum gas (LPG)

This report deals mainly with petrol, diesel, IP, LPG and jet fuel. Fuel oil information is combined with other stationary type fuels where necessary.

Liquid fuels are made in South Africa either by refining crude oil (about 70%) or by conversion of coal and natural gas (about 30%). South Africa's consumption of liquid fuels over the decade to 2001 is shown in Figure 35.

Figure 35 Consumption of Liquid Fuels in South Africa 1992-2001



Source: World Energy Council, South African Energy Profile 2003

While petrol consumption has traditionally been dominant, Figure 35 shows a potential swing in diesel and petrol consumption patterns.

CTMM represents nearly 30% of Gauteng's IP consumption, a quarter of its petrol and a fifth of its diesel as shown in Table 18. From the data provided by SAPIA, it appears that no LPG is sold within Tshwane, or at least that no records of such sales are kept.

Table 18 Regional and national use of liquid fuels, kl 2004.

Area	Petrol - All grades	Diesel Gas Oil - All grades	Illuminating Paraffin	Liquid Petroleum Gas
CTMM	1,011,111	333,238	41,913	-
Gauteng	4,096,146	1,733,426	141,545	63,936
South Africa	10,980,373	7,668,730	796,318	563,558
CTMM, % of Gauteng	24.7%	19.2%	29.6%	0.0%
CTMM, % of national total	9.2%	4.3%	5.3%	0.0%

Source: http://www.mbendi.co.za/sapia/rsacons.htm#QUARTERLY

Data for liquid fuels is still available only by magisterial district. Table 19 below presents the available data for four of the five magisterial districts – Temba is not available on the SAPIA database.

Table 19 Consumption of liquid fuels per magisterial district (2004)

Magisterial District	Petrol	Diesel	Avgas	Furnace oil	IP	LPG	Total	% of total	Jet fuel
Odi (Ga-Rankuwa)	46,281	7,751			13,199		67,231	5%	
Pretoria	834,438	289,103			27,170		1,150,711	83%	
Soshanguve	43,344	7,868			49		51,262	4%	
Wonderboom	87,047	28,515			1,495		117,058	8%	
Temba							0	0%	
Total	1,011,111	333,238	0	0	41,913	0	1,386,263	100%	0
% of total	73%	24%	0%	0%	3%	0%	100%		

Source: SAPIA

In terms of total municipal use, petrol is by far the dominant liquid fuel that is used within CTMM (73%) followed by diesel (24%), with low usage of the other liquid fuels. Pretoria is by far the largest consumer of liquid fuels.

Table 20 below indicates the consumption of liquid fuels in the Pretoria magisterial district. Again, petrol is the most consumed liquid fuel at 68%, followed by diesel at 24%. As would be expected, service stations are the dominant marketing channel.

Table 20 Consumption of liquid fuels by marketing channel (Pretoria, 2004)

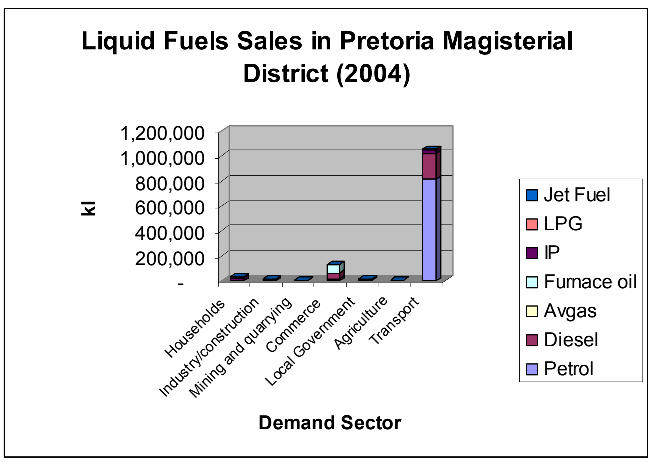
Marketing channel	Petrol	Diesel	Avgas	Furnace oil	IP	LPG	Total	% of total	Jet Fuel
Service stations	740,946	123,769	1		1,664	290	866,669	71%	
Other resellers	67,684	37,363	61		23,396	8,216	136,719	11%	
Farmers	35	2,797	0	121	151	0	3,105	0%	2
Co-ops	236	3,366			250		3,851	0%	
Other commercial	15,220	48,979	1,890	62,618	1,697	1,748	132,153	11%	957.6
Central government	4,970	2,393	116		7	5	7,490	1%	2019
Local government	1,467	6,771					8,238	1%	
Transnet		16			1		17	0%	
Mining	33	5,157			0		5,190	0%	
Construction	21	10,315			1		10,338	1%	
Buses	2,295	23,523					25,818	2%	
Road trucks	1,319	24,656			3		25,978	2%	
Total	834,226	289,103	2,068	62,739	27,170	10,260	1,225,565	100%	2,979
% of total	68%	24%	0%	5%	2%	1%	100%		0%

Source: SAPIA

As can be seen, jet fuel is consumed in this area although this is not recorded in the SAPIA database by magisterial district. This will be clarified with SAPIA during the next stage of the project.

When grouped into demand sectors, the data clearly show that transport is the dominant consumer of liquid fuels, and again that petrol is the most-consumed fuel.

Figure 36 Liquid fuels sales in Pretoria Magisterial District (2004)



5.2.2 Piped Gas and LPG

5.2.2.1 Sasol Gas

Sasol gas is employed in industrial and commercial, rather than domestic, markets. Gas is delivered at three points in Tshwane, Babelegi, Rosslyn and Pretoria West. The trends in consumption at each of these points are illustrated in Figures 16, 17 and 18. Cumulative consumption for Tshwane is illustrated in Figure 19.

Figure 37 Gas Consumption in Rosslyn

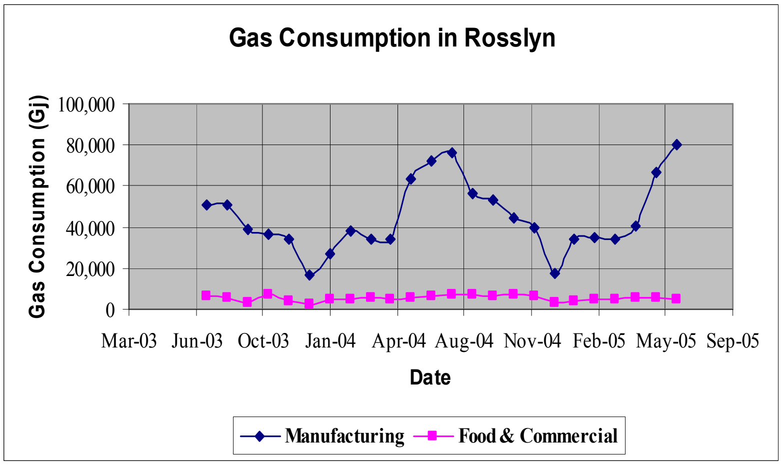


Figure 38 Gas Consumption at Babelegi

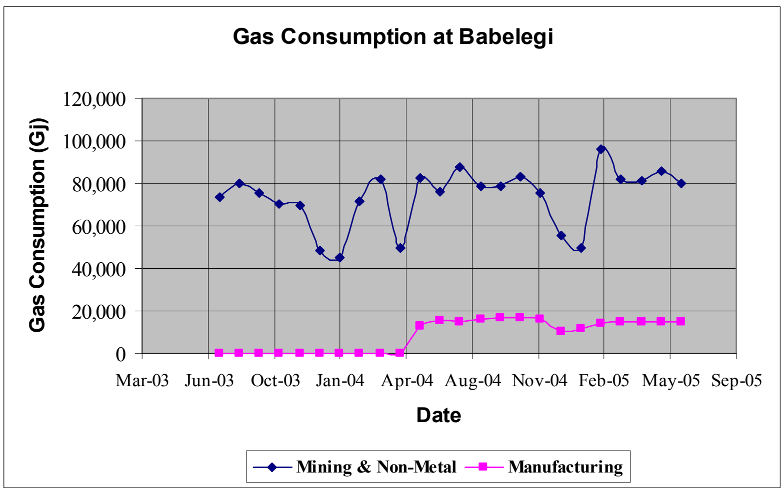


Figure 39 Gas Consumption in Pretoria West

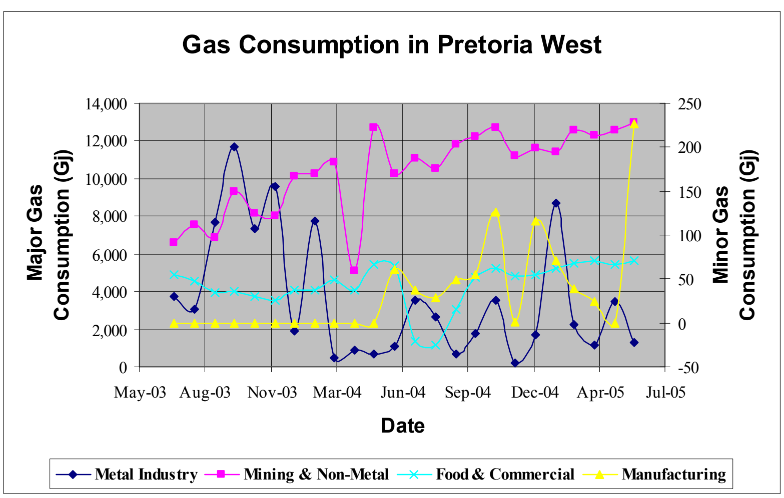
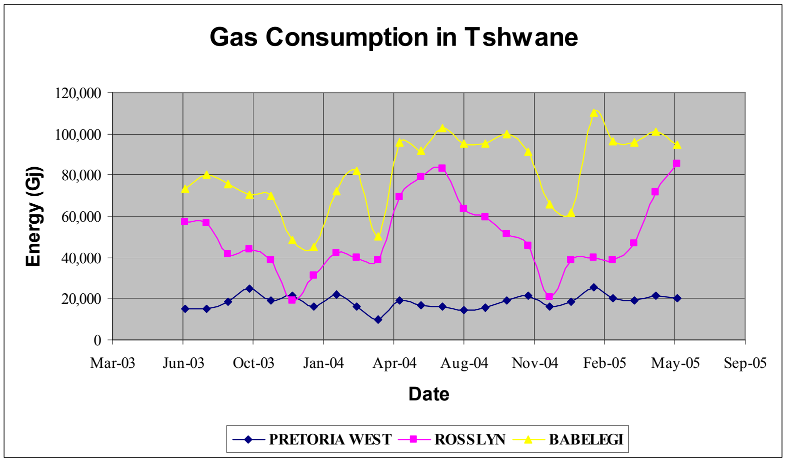


Figure 40 Gas Consumption in Tshwane



5.2.2.2 LPG

Gas, particularly LPG, is a source of energy growing in importance. Suppliers are giving much attention to capturing some of the domestic market from more traditional energy sources such as electricity and coal. The 350 000 tonnes of LPG consumed nationally, each year, has the following consumption pattern:

- Commercial 19%
- Industrial 41%
- Agriculture 6%
- Mining 1%
- Automotive 0.1%
- Domestic 33%

5.2.3 Electricity

This section sketches the context within which electricity is provided within the CTMM boundary, and provides the following:

- An introduction to electricity and electricity issues in South Africa
- Connection profile – number and type of electricity customers for CTMM and Eskom
- Consumption profile – a breakdown of electricity consumers by demand sector
- Forecast trends in demand

5.2.3.1 Introduction to Electricity

5.2.3.1.1 Understanding Electricity Units

There are two main units of electricity one needs to understand – instantaneous power and energy consumed. Instantaneous ***power*** gives an idea of how many appliances a household can operate at the same time – this will indicate how much electrical current the household can draw before the circuit breakers will trip. ***Energy*** represents how much power is consumed over time, and is the basis for billing for household electricity use.

To assess how much current a typical household would draw at a given time, one must look at the total power consumed by the sum of the appliances operating at that time. A household could run, for instance, three 60W bulbs, a kettle, a fridge and a TV simultaneously. Power consumed by an appliance is measured in Watts for purely resistive loads as would be found in poor households, and in Volt-Amperes (VA) for inductive loads caused by the use of e.g. electric motors. These units are usually expressed in either kilowatts (kW) or kilo-volt-amps (kVA), with the prefix kilo representing a factor of 1000 as explained in Section 4.1.

Power for household use is calculated as the voltage (measured in Volts) times the current drawn, which is measured in Amperes (amps). In other words, Power (W) = Voltage (V) x current (A). In South Africa, electricity is supplied at 220 V. This means that at any given time, based on the estimates in Table 21, a household running a fridge, a kettle, a couple of electric lights and a television could be drawing:

(250+1000+2*60+35)W/220V

= 1405W/220V

= 6.4 Amps

Consumption (energy) is power consumed over time, measured in kilowatt-hours. The following table gives an indication of the energy consumption of various basic appliances, providing perspective on household energy usage.

Table 21 Indicative Energy Consumption of Household Appliances

ITEM	QUANTITY	RATED POWER (W)	HOURS USED PER DAY	DAYS USED PER MONTH	kWh
Energy Saver Light	1	11	5	30	1.7
Light	3	60	5	30	9
Light	1	100	5	30	15
TV (b&w)	1	35	6	30	7
Iron	1	1000	4	6	24
Kettle	1	1000	0.5	30	15
Hotplate	1	1000	1	25	25
Fridge (small)	1	250	6.5	30	49

5.2.3.1.2 Levels of Service

The Levels of Service shown in Table 22 have been set across consumer classes in South Africa.

Table 22 Levels of Service for Electricity

LOS	DESCRIPTION	STANDARD	GROUP	LOS No	DESCRIPTION	Size hh	UNITS per AREA (ha)	Peak factor Demand	ELECTRICAL Households	Demand	Kva/ha
1	BELOW BASIC	None	A	10	Informal	4	40	0	None	0	0
1	BELOW BASIC	Sub-Standard	B	15	Informal	4	40	0	Non-grid & other sources	<0.5 kVA/hh	0
1	BELOW BASIC	Sub-Standard	C	18	Informal	4	40	0	Non-grid & other sources	<0.5 kVA/hh	0
2	BASIC	RDP Standard		20	Township/Informal	5	25	0.0167 kVA/hh	5/8 Amperes 1 Phase	0.5 kVA/hh	20
3	INTERMEDIATE	Low	A	30	Township	6.5	20	0.0167 kVA/hh	20 Amperes 1 Phase	1.5 kVA/hh	33.5
3	INTERMEDIATE	High	B	35	Township	6.5	20	0.0167 kVA/hh	20 Amperes 1 Phase	3 kVA/hh	75
4	FULL SERVICE (LOW INCOME)	Low	A	40	Residential	5.5	17	0.025 kVA/hh	60 Amperes 1 Phase	4 kVA/hh	100
4	FULL SERVICE (LOW INCOME)	High	B	45	Residential	5.5	17	0.025 kVA/hh	60 Amperes 1 Phase	5 kVA/hh	125
5	FULL SERVICE (HIGH INCOME)	Low	A	50	Residential	4.5	7	0.025 kVA/hh	60 Amperes 1 Phase	6 kVA/hh	60
5	FULL SERVICE (HIGH INCOME)	High	B	55	Residential	4.5	5	0.025 kVA/hh	60+ Amperes 1 or 3 Phase	8 kVA/hh	80
6	INDUSTRIAL	Light loading	A	60	High industry	–	–				200
6	INDUSTRIAL	Medium loading	A	63	Medium industry	–	–	–	–	–	120
6	INDUSTRIAL	Heavy loading	B	65	Low industry	–	–				50
7	COMMERCIAL	Low density	A	70	Commercial	–	–				250
7	COMMERCIAL	High density	B	75	Commercial	–	–				500

The RDP Level of Service was set as a minimum 5/8 Amp connection. The accepted connection level is now a single phase, 20 Amp connection. Most of Tshwane households are connected at this level. Some are connected with a three phase, 20 Amp connection, and in some farming areas, households are connected with a single phase 60 Amp connection.

The type of connection has an influence on the type of economic activity which can be carried out at the household level – if a household has a three phase connection, then electromechanical equipment characterised by inductive loading (such as motors to drive pumps and compressors) can be used.

5.2.3.1.3 Free Basic Services

As part of the Government's strategy to alleviate poverty in South Africa a policy for the provision of a free basic level of services has been established. Much of the ultimate responsibility for delivering free basic services will rest on local authorities. For electricity, this policy has been agreed to at Cabinet level. An amount of 50 kWh per month, known as Free Basic Electricity (FBE), has been deemed sufficient energy to provide basic services for a poor household. This amount of electricity is suitable for basic lighting, TV and radio, basic ironing and basic cooking. Using energy efficient appliances can extend this amount.

As shown in Table 21, for most households, 50 KWh per month would address the use of a small fridge for 6-1/2 hours each day. This highlights the need for energy efficient lighting and appliances.

FBE has been set up as a self-targeting mechanism. Implementation across the municipalities in Gauteng varies, often with the result that all customers receive FBE even if they can afford electricity. Tshwane Electricity has adopted a policy of universal access to FBE.

5.2.3.2 Connection Profile

The electricity customer base in CTMM, including those customers served by Eskom (mostly in the north), is summarised in Table 23.

Table 23 Electricity Customer Base within the Tshwane Boundary

Electricity Service Provider	Number of Customers (2004)
CTMM	329 531
Eskom (conventional meters)	2 019
Eskom (prepaid meters)	57 500
Total	389 050

Source: CTMM submission to NER and Eskom Distribution, Northern Region

5.2.3.2.1 Discrepancy between national census and CTMM statistics

Given the number of household customers for CTMM and Eskom combined in 2004 (389 050), the urban electrification rate of 64.9% in Gauteng in 2003[11] (NER), together implying that there are currently about 599 460 households in Tshwane, and the number of households reported in the national census escalated to 2005 (620 901)[12], it appears there may be a slight discrepancy between the census and CTMM's statistics. This will be discussed with CTMM Electricity Department and reconciled if possible.

5.2.3.3 Consumption Profile

Demand for electricity is expressed in terms of energy consumption in MWh and peak power demand in MW or MVA. CTMM Electricity provided sales data in terms of energy consumption, peak power and associated revenues for large power customers consuming less than 10 GWh per year, as summarised in Table 24. This represents the consumption of three industrial consumers, seven commercial consumers (including four educational sites), one local government consumer and one transport sector consumer. For the purpose of establishing peak demand, a diversity of 80% has been assumed.

Energy consumption for large power consumers with a total consumption of more than 10 GWh for the period of July 2003 to June 2004 was provided, as summarised in Table 15. This represents the consumption of 20 industrial and 33 commercial consumers.

Table 24 Energy and Demand Profile for Large Power Consumers (<10 GWh/yr)

Month (yy-mmm)	Energy (MWh)	Demand (MW/MVA)	Revenue (Rand)
04-Jan	36,323	60	R 6,277,107
04-Feb	35,959	69	R 6,526,922
04-Mar	37,894	58	R 6,485,962
04-Apr	35,364	57	R 6,051,934
04-May	38,758	60	R 6,602,003
04-Jun	39,855	66	R 8,801,708
04-Jul	42,312	67	R 9,358,732
04-Aug	40,703	67	R 8,817,301
04-Sep	38,418	63	R 6,575,104
04-Oct	39,744	68	R 6,776,847
04-Nov	38,265	65	R 6,623,597
04-Dec	34,710	62	R 6,050,542
05-Jan	34,596	73	R 5,992,857
05-Feb	35,221	83	R 6,436,875
05-Mar	37,612	89	R 6,897,177
05-Apr	38,309	79	R 6,663,259
05-May	39,666	84	R 6,950,329
05-Jun	40,190	92	R 9,109,598

[11] NER, http://www.ner.org.za/stats/statistics_gauteng.htm

[12] GTZ Population Planning Assessment Model, Excel spreadsheet used by Africon, 2005

Table 25 Energy Consumption for Large Power Consumers (>10 GWh/yr)

Month	Energy (MWh)
Jul-03	149,689
Aug-03	146,308
Sep-03	142,125
Oct-03	148,598
Nov-03	141,131
Dec-03	140,912
Jan-04	142,606
Feb-04	145,200
Mar-04	140,543
Apr-04	155,396
May-04	152,523
Jun-04	144,485

5.2.3.4 Trends in Demand

CTMM and Eskom are presently engaged in intensive electrification measures, which amount to 10 000 and 12 000 new connections per year respectively, for a total of 22 000 new connections annually. These are significant targets and represent a concerted effort to eradicate the estimated backlog of 160 000 households[13] still without electricity.

5.2.4 Coal

Coal demand has been assessed through interviews of major suppliers and consumers of coal within the Tshwane boundaries. No coal is produced within Tshwane, so all supply was considered as imports in the energy balance. Annual coal consumption in Tshwane derived through these interviews is summarised in Table 26 overleaf.

Since primary energy accounts for a significant component of the input cost in many energy intensive industries, users are sensitive to price signals and regularly scan the market for energy options. In addition to the above environmental legislation and legal requirements also plays a significant role in the selection of the desired energy source. Conversion costs and payback periods normally play a major role in energy carrier decisions. To illustrate this point, SAB have developed a business case for substituting gas for coal and are currently converting their coal boiler system to a gas-driven system.

[13] Tshwane City Development Strategy, Bulk Services Situational Assessment, August 2005

Table 26 Annual Coal Consumption in Tshwane (2004)

Coal Consumer	Demand Sector	Average Consumption (tonnes per period)	Period	Estimated Coal Consumption (tonnes per year)	Supplier
Laundry					
o Unitas Hospital	Commercial	100	3 mo	400	
o George Mukare Hospital	Commercial	30	1 day	10,800	
o Other hospitals	Commercial	TBD			
o Prisons	Government	TBD			
SAB Rosslyn	Industrial	2,480	1 month	29,760	Chandler
PPC	Industrial	65,400	1 year	65,400	McPhail
Coca-Cola	Industrial	90	1 month	1,080	McPhail
Small Industries	Industrial	30,000	1 year	30,000	
Pretoria West	Power Generation	101,022	1 year	101,022	Landau
Rooiwal	Power Generation	584,489	1 year	584,489	Greenside & Landau
Sub-total, major consumers				822,951	
Households				266,023[14]	

Since it is not part of the sales culture to keep records of the amount of coal bought by coal users within the household and small industries sectors, it is difficult to obtain accurate consumption figures for these demand sectors.

However, an estimate was made through using the coal market consumption segmentation as a basis, as it can be assumed that the household demand is close to the difference between the total coal supply and major consumer demand shown in Table 16.

It was estimated[15] that 63% of small industries burn coal and/or anthracite.

---

[14] Estimated from the difference between total coal supply and major consumer demand (see Section 6.4 for total coal supply

[15]CTMM, "Fuel Burning Appliances.xls"

5.2.5 Biomass

5.2.5.1 Animal dung

Of all the energy carriers reviewed in this study, animal dung is the least commercial and monetised. Animal dung is little used in Tshwane (as shown in Figure 25 through Figure 27), although it is expected that in some of the rural areas it may be used for heating and cooking. It has a non-energy use for the plastering of huts in rural areas.

5.2.5.2 Wood

Little woodfuel is used in Tshwane relative to electricity, gas, IP and coal. The bulk of the woodfuel use occurs in the rural and agricultural areas.

6. ENERGY SUPPLY

This section deals with energy supply by carrier, i.e. by fuel type.

6.1 LIQUID FUELS

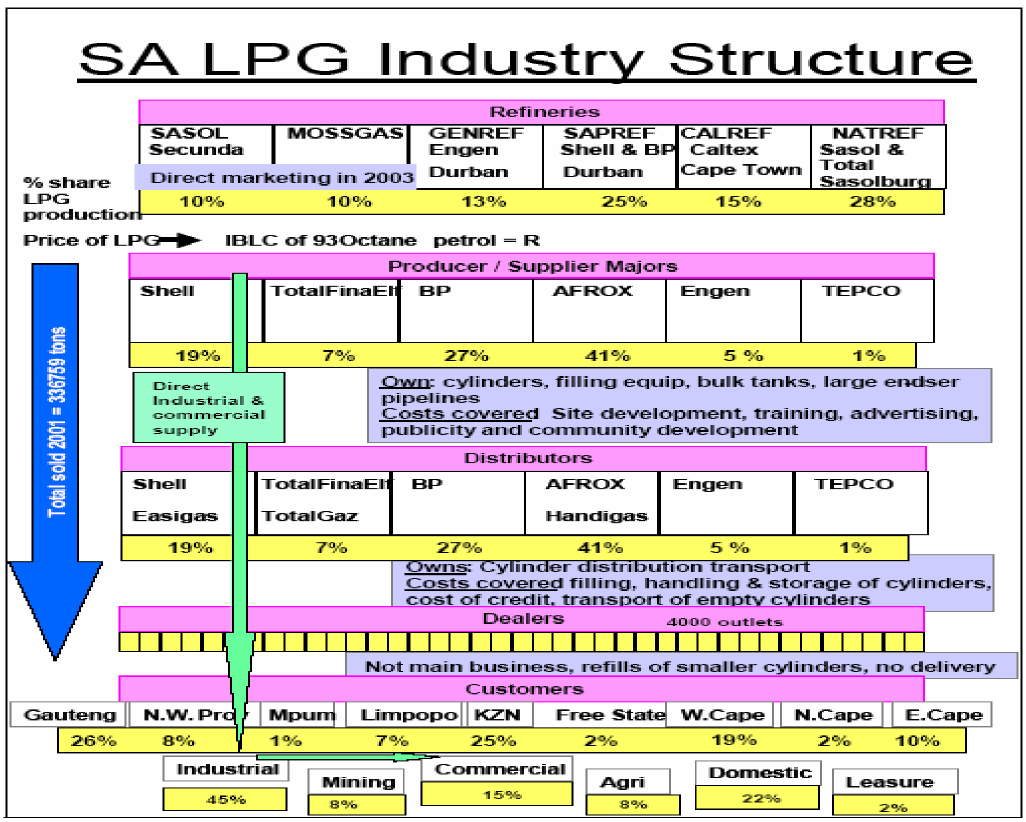
6.1.1 Supply chain

At present there are seven refineries in South Africa. Of these, four are of conventional design as they convert mainly imported crude oil to a series of refined products (Cape Town, two in Durban and Sasolburg), one uses natural gas as the feedstock (Mossgas) and two use coal and are termed synfuel plants (Secunda). These refineries produce a range of products to satisfy the market demand. In addition, they export surplus production as is determined by the technology of the specific refinery and the demand of the local market.

Most of these refined products are transported by means of pipelines to main depots where the marketing components of the fuel companies takes ownership and transports to depots, resellers and filling stations by means of road or rail tanker. It is therefore not possible to identify the source of a specific product. Sales in CTMM would most possibly come from Sasolburg, Secunda and possibly Durban.

The South African LPG distribution chain shown in Figure 41 below is a typical petroleum supply and distribution chain. Gauteng is the major consumer of LPG, but mostly for industrial and other commercial enterprises.

Figure 41 Industry structuring and market share of LPG



Source: DME & UNDP (2004)

The LPG distribution is not as long and complex as the paraffin distribution chain (shown in Figure 42) and often does not extend as close to homes as would be desired. One assumption is that this situation is due to the greater safety requirements associated with LPG handling. Routers (bulk distributors), which are financially supported by oil companies to set up their operations, are responsible for distributing paraffin to retailers.

6.1.2 Distribution and Marketing of Liquid Fuels

Liquid fuels are marketed by a variety of channels, from direct in the form of large contracts by large consumers to marketing via service stations and other resellers. Table 28 provides this breakdown for the Pretoria magisterial district.

Table 27 Marketing of the different liquid fuels in Pretoria (kl, 2003)

Marketing channel	Petrol	Diesel	Avgas	Furnace oil	IP	LPG	Total	% of total	Jet Fuel
Service stations	740,946	123,769	1		1,664	290	**866,669**	**71%**	
Other resellers	67,684	37,363	61		23,396	8,216	**136,719**	**11%**	
Farmers	35	2,797	0	121	151	0	**3,105**	**0%**	2
Co-ops	236	3,366			250		**3,851**	**0%**	
Other commercial	15,220	48,979	1,890	62,618	1,697	1,748	**132,153**	**11%**	957.6
Central government	4,970	2,393	116		7	5	**7,490**	**1%**	2019
Local government	1,467	6,771					**8,238**	**1%**	
Transnet		16			1		**17**	**0%**	
Mining	33	5,157			0		**5,190**	**0%**	
Construction	21	10,315			1		**10,338**	**1%**	
Buses	2,295	23,523					**25,818**	**2%**	
Road trucks	1,319	24,656			3		**25,978**	**2%**	
Total	**834,226**	**289,103**	**2,068**	**62,739**	**27,170**	**10,260**	**1,225,565**	**100%**	**2,979**
% of total	**68%**	**24%**	**0%**	**5%**	**2%**	**1%**	**100%**		**0%**

As can be seen in Table 28, the most important marketing channel is by means of service stations (71% of total sales), followed by "other resellers" (11%) and the direct marketing to larger companies as "other commercial" and "road trucks", which combined comprise 13% of the total.

6.1.2.1 Distribution and Retail of Petrol and Diesel

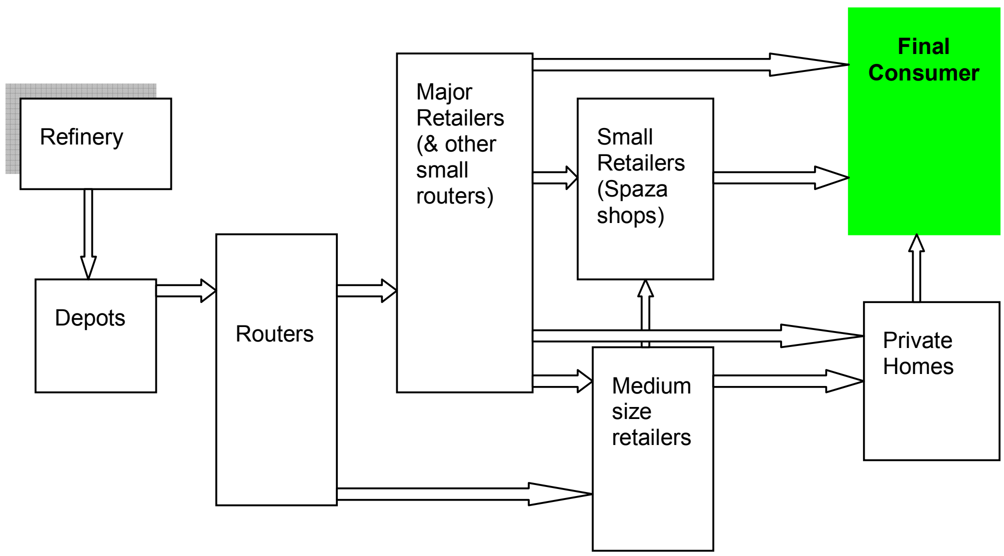
Service stations are approved on a roster basis to ensure that all parts of the country are provided with an efficient system of fuel supply and to guard against the proliferation of service stations. Local authorities are responsible for local approvals in terms of land use approval, vehicle access to sites and health and safety in terms of local and national regulation.

6.1.2.2 Distribution and Retail of Illuminating Paraffin

Paraffin can be purchased from a number of outlets, the most common being informal spaza shops and individual homes, formal supermarkets and filling stations. The degree of accessibility varies from one area to another. To a large extent this established paraffin distribution network has worked well in promoting the use of paraffin in poor communities. On the other hand, the long paraffin distribution chain works to the disadvantage of the final consumer, as shown in Figure 42).

Even when the refinery price of paraffin is reduced and/or zero-rated for VAT, this normally does not filter through to the final consumer. The major beneficiaries are the various distributors, intermediaries in the distribution chain and a few bulk-buying households. Since many poor households purchase paraffin in small quantities, they often do not realise the benefits of price reduction since they are likely to have bought their IP supplies from small spaza shops or private homes selling paraffin to supplement income.

Figure 42 A typical complex paraffin distribution chain



6.1.2.3 Distribution and Retail of LPG[16]

Compared to other similar economies, South Africa has the least penetration of LPG in the residential sector, as shown in Table 28. Some of the reasons for this are the corresponding cheap price of coal-generated electricity, as well as the unusually high price of LPG. In Botswana, LPG is significantly cheaper than in South Africa.

Table 28 Comparison of LPG consumption in emerging economies

Per Capita residential LPG consumption		
Country	**kg/year**	Notes
Argentina	27.9	1. Non South African figures from year 1999, obtained from the World LPG Association
Brazil	37.4	
Morocco	34.0	2. South African figure, based conservatively on a population of 40 million, a total LPG market of 336 755 tons in 2001 and a 22% residential market share
Egypt	36.2	
Algeria	47.8	
Senegal	10.3	
South Africa	**1.9**	

Source: DME & UNDP (2004), www.langegas.com/statwle.htm

The DME has undertaken to institute trial programmes, involving LPG suppliers, to establish the economic parameters involved in the replacement of coal and IP with LPG. South African

[16] Most of the data and analysis adapted from DME & UNDP (2004): LPG Rural Challenge Workshop, South Africa – Workshop Background and Briefing paper.

LPG appears to be more costly than in other parts of the world and the intention is, through price reduction and, possibly, subsidisation, to bring LPG within the reach of lower income groups.

6.1.3 Petrol and Diesel

Both fuels are used mainly in vehicle transport; diesel is also used in power production. South Africa is a net exporter of both petrol and diesel. Diesel is denser than petrol and has a lower calorific value, and internationally is generally less expensive on a volumetric basis. As shown in Table 27, the consumption of petrol and diesel in Tshwane was 834 226 kl and 289 103 kl respectively in 2004.

In environmental impact terms, the burning of petrol in an internal combustion engine produces more carbon dioxide than does diesel, which in turn produces more NOx and SOx than petrol. With improving diesel-refining techniques, sulphur levels are being reduced, thereby improving the overall profile of diesel as a transport fuel in comparison to petrol.

6.1.4 Illuminating Paraffin

Paraffin is very similar to jet fuel in chemical composition. It is sold in bulk liquid format, usually from fixed storage tanks or small, portable 200, 20 or 5 litre drums. Although it is often mistaken for water, it is highly toxic, highly flammable and has a very low viscosity. Nearly 800 million litres are manufactured and sold each year nationally (Truran 2004).

As shown in Table 29, about 92% of the illuminating paraffin (IP) used in Tshwane is consumed by households. The commercial and agricultural sectors represent the other main consumers of IP, although at 6.2% and 1.5% respectively, this could be considered negligible.

Table 29 Sectoral Demand for Illuminating Paraffin in Tshwane

Sector	Consumption (%)
Households	92.2%
Industry/Construction	0.0%
Commercial	6.2%
Mining & Quarrying	0.0%
Agriculture	1.5%
Transport	0.0%
Government	0.0%
Total	100.0%

This is expected, considering the fact that IP is predominantly used for lighting and cooking in comparatively less affluent households. The subsidy put on IP by the Government through exemption from VAT encourages its use by households with relatively low incomes and farmers who use it as a diesel additive/substitute.

Recently, the Paraffin Safety Association has mounted campaigns to improve the safe use of paraffin. Interviews conducted with experts suggest that accidents caused by IP emanate from ingestion by children as well as accidental knocking-over, in particular, during the night. Most fires and burns in poor settlements have been attributed to the use of paraffin. As indicated elsewhere in this report, the DME is promoting LPG and other low-smoke fuels (coal) in order to minimise the use of paraffin, due to its toxicity when ingested, ease of spreading fires and illicit use by farmers through mixing with diesel. Paraffin appliances are usually more affordable, albeit substandard. The SABS has recently launched a campaign to improve the quality of paraffin stoves.

6.1.5 Liquefied Petroleum Gas (LPG)

The terms LPG and LNG are related and are sometimes used interchangeably (erroneously) in South Africa. For clarity, the terms are defined below.

LPG consists primarily of propane, propylene, butane, and butylene in various mixtures. It is derived from natural gas deposits and is also produced in the crude oil refining process. It is stored as a liquid by increasing pressure. LPG is the generic name for commercial propane and commercial butane.

Natural gas is primarily methane, and other hydrocarbons (including propane and butane), water, carbon dioxide, nitrogen, oxygen and some sulphur compounds. Liquefied natural gas (LNG) is natural gas that has been cooled to -259 degrees Fahrenheit (-161 degrees Celsius), at which point it is condensed into a liquid, which is colourless, odourless, non-corrosive and non-toxic. During the liquefaction process, natural gas is cooled below its boiling point, removing most of these other compounds. The remaining natural gas is primarily methane with only small amounts of other hydrocarbons. In South Africa, the source for natural gas is the offshore field just south of Mossel Bay.

The major consumers of LPG in Tshwane are households and commerce, with demand figures of 82.9% and 17.0% respectively as shown in Table 30 below. The relatively low consumption figure for industry/construction is because this sector relies more on electricity, piped gas and cheaper liquid fuels for its energy requirements.

Table 30 Sectoral Distribution of LPG in Tshwane

Sector	Consumption (%)
Households	82.9%
Industry/Construction	0.0%
Commercial	17.0%
Mining & Quarrying	0.0%
Agriculture	0.0%
Transport	0.0%
Government	0.0%
Total	100.0%

There are plans to accelerate the use of LPG in the residential sector, particularly in low income households in order to reduce the use of dangerous IP. A strategy is being developed by the DME to roll out LPG, and it is envisaged that municipalities will play a key role in implementing the LPG strategy.

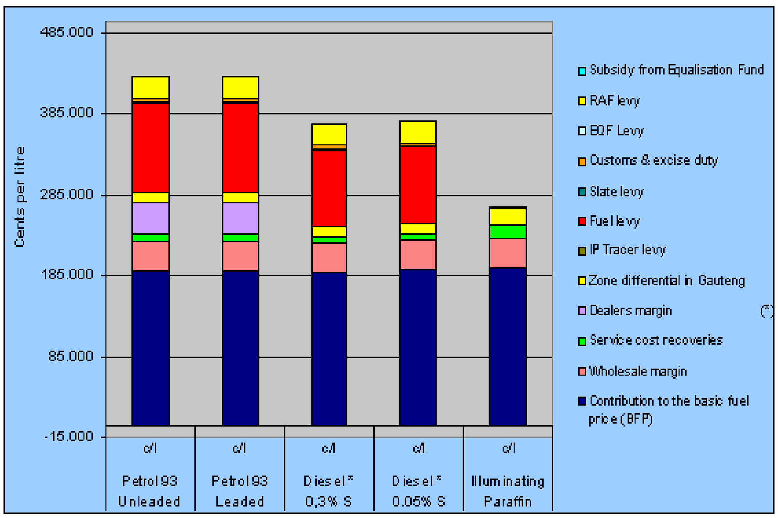
6.1.6 Policy and regulatory context

Government has for many years' regulated parts of the liquid fuel sector. At present the refinery gate price of petrol, diesel, IP and LPG is controlled, as is the retail price of petrol. These prices are based on the international crude oil price and are adjusted monthly.

6.1.7 Liquid fuel pricing

The government uses a recently introduced formula, the Basic Fuel Price (BFP) [17] to calculate liquid fuel prices. The BFP is an import parity pricing formula based on spot prices, introduced to replace the in-bond landed cost (IBLC) formula in use in South Africa from the 1950s to 2003, which calculated the cost of landing the product at specified South African ports, based on posted prices from a basket of four foreign refineries (one in Bahrain and three in Singapore). The objective of using import parity pricing is to match the cost of importing finished product.

Figure 43 Composition of the Retail Price of Petrol and the Wholesale Price for Diesel and IP in Gauteng for the period 01/09/2004 30/09/2004



Source : http://www.shell.co.za/vpower/pprice.htm

6.1.7.1 Petrol, Diesel and IP Prices

The basic price of petrol is based on 50 per cent Platts' (a price reporting agency) spot price assessment in the Mediterranean refining area and on 50 per cent Platts' spot price assessment in Singapore. (The IBLC formula was based on 80 per cent posted prices at refineries in Singapore and Bahrain and on 20 per cent spot prices in Singapore). The basic prices of diesel and illuminating paraffin are based on 50 per cent Platts' spot price assessment in the Arabian Gulf and on 50 per cent of Platts' spot price assessment in the Mediterranean area[18] .

These prices have recently been severely affected by constraints on international refining capacity, limiting the availability of finished product.

---

[17] This a system or methodology which was implemented in April 2003, and based on the revised import-parity pricing for determining a refinery gate price, and a rate-of-return mechanism to calculate the wholesale price and cost recovery for retail margins. Therefore, BFP price is not really a regulated price at the refinery gate since refineries are not legally bound to sell their products at this price.

[18] The IBLC formula was based on 80 per cent posted prices at refineries in Singapore and Bahrain and on 20 per cent spot prices of refineries in Singapore. (These prices are sourced from http://www.transportandconstruction.co.za/press/press200029.html).

Table 31 Prices for liquid fuel products, 2003

	Petrol retail	Diesel wholesale	IP wholesale
Average price, c/litre	393.1	338.9	248.3
Minimum price (June 2003)	361	298.9	209.3
Maximum price (April 2003)	426	391.9	294.3

6.1.7.2 LPG Price

At present the retail price of LPG is not regulated. The price of LPG is controlled and regulated by the DME at the refinery gate, by the imposition of a maximum transfer price, based on the BFP formula for Mossgas 93, less R75 per tonne.

- The nominal refinery gate price is based on the IBLC. The current maximum refinery gate prices of LP Gas are R2,348 per tonne at the SAPREF, Engen, Calref and Mossgas coastal refineries and R2,676 per tonne at the Secunda inland refinery.
- The current retail price as indicated by one of the major companies is R49.92 per 9 kg fill (coastal) and R54.41 per 9 kg fill (inland), which equates to R5,547 per tonne (coastal) and R6,046 per tonne (inland).
- Added to this, resellers can add approximately R30 to a 9 kg fill (R79 to R84 per 9 kg fill). This equates to R8, 880 per tonne (coastal) and R 9,379 per tonne (inland). It is clear therefore that a very significant part (around 70%) of the retail price is made up of distribution costs and margins. It should be noted that some retail outlets sell 9kg cylinders at R65, including VAT[19].

Table 32 Price build up from supply to end-use

LPGas Price build up		
Supply Chain Incremental	**Margin**	**Price**
Producer - Refining & delivery to factory gate	R2.5/kg	R2.5/kg
Distributor – Set up dealers and bulk delivery	R1.4	R3.9
Principal Agents - fill and distribute cylinders	R1.6	R5.5
Retailers – Point of purchase by the customer	R2.00 to R5.00/kg-	R7.50 to R10.50/kg

Note: Typical example only. Great variation possible.

While LPG is not a controlled product (meaning that its retail price remains unregulated), the DME is considering regulating the price using petrol-related import parity pricing, but it is not clear whether regulating the price would contribute to lower prices to the consumer. The

[19] Much of this analysis is based on the recently completed study by the CI Services (LTD) Pty (March 2004), "The LPG Rural Energy Challenge: South Africa LPG Industry Report".

experience, for instance, with the removal of VAT in the retail price of IP is not entirely satisfactory. The commissioned National Treasury study (CIS 2004) reveals that the “subsidies have not reached the beneficiaries”. It is anticipated that a regulated LPG retail price will face the same problem and the biggest challenge would, as with IP, be the “policing” the price or at least communicating the price to the consumers.

6.1.7.3 Illuminating paraffin price

VAT is not applied to paraffin sales. Paraffin is a regulated product and the DME sets the maximum retail price monthly. The September 2004 regulated price of paraffin was R 2.05 per litre (coastal) and R 3.03 per litre (inland), however it is reported that these prices are not enforced.

6.1.8 Trends and developments

The energy balance (Table 9) has shown that transport energy is the major energy user in CTMM. It is also the major energy related source of pollution. The South African government plans to supply clean petrol and diesel as from 2006. The various transport planning and rationalisation activities are also expected to lead to a more efficient transport sector with lower energy use. Two topics that also need to be addressed are the use of low energy use bicycles and pedestrian transport, both of which have very specific planning and legislation and implementation implications. They at present are administered in a very ad hoc fashion with significant consequences in terms of lack of safety.

Extensive new transport technology developments, such as the highly efficient hydrogen vehicle, are expected during the next decade. A model of the hybrid (electric/fossil fuel) vehicle has recently been introduced in South Africa. These developments will have to be monitored and addressed in terms of infrastructure and policy when they become a commercial reality.

6.2 PIPELINE GAS

In 1964 Sasol Gas as it is known today was established and started with the construction of its first pipeline to supply hydrogen rich gas to industrial consumers in Gauteng from the Sasol works at Sasolburg. This pipeline was completed in 1966 at a cost of R30 million and connected 250 consumers to the network. A second backup pipeline of 95 km was constructed in 1981 that connected the Secunda plant to the gas network at Springs. At present Sasol Gas supplies in excess of 700 industrial customers in Gauteng and Mpumalanga via a pipeline network in excess of 1400 km from the production plants at Sasolburg and Secunda. Since 1998, pipeline gas is also supplied to KwaZulu Natal via a Petronet pipeline. In Tshwane, the gas pipeline delivers gas to Rosslyn, Pretoria West and Babelegi.

6.2.1 Developments at the national level

Sasol is delivering natural gas from the Temane gas field in Mozambique via the Temane-Secunda gas pipeline. The DME’s view on the impact of this additional carrier in the South African energy market, as expressed in the Integrated Energy Plan, is the initial capacity of the gas transmission pipeline is 120 MGJ per year. To place this into perspective, the 120 MGJ per year is equivalent to approximately 3800 MW, which assuming a 50% conversion efficiency to electricity, is equivalent to 1900 MWe or approximately one half an

Eskom ("six pack") electricity generation station. Approximately one third of the natural gas coming from Mozambique is scheduled to be used by Sasol as a replacement for coal as a feedstock, another one third is scheduled to replace syngas in Sasol's existing gas market, and the remaining one third is to go into Sasol's expansion of the gas market."

The Government has been considering mechanisms for encouraging SMMEs to engage in the gas business, as spinoffs from the pipeline. The Government has also looked at the potential for the introduction of natural gas to derive Clean Development Mechanism (CDM) credits through a Central Energy Fund (CEF) project funded by the Public Private Infrastructure Advisory Facility (PPIAF) of the World Bank.

6.2.2 Supply of piped gas in CTMM

The supply of pipeline gas in 2004 amounted to 1 812 TJ (ref Table 9), supplied through Babelegi, Rosslyn and Pretoria West as shown in Figure 37 through Figure 39.

6.2.3 Policy and regulatory context

The enactment of a Gas Act in 2002 that makes provision for the appointment of a natural gas regulator, the crafting of Petroleum Pipeline Bill and the National Gas Infrastructure Development Plan provide an enabling environment for the growth of the gas industry in the country. These developments are sequel to the key policy challenges in the White Paper on Energy Policy of 1998. The key policy objectives are for the development of the gas industry to stimulate inter-fuel competition, provide relatively lower gaseous emissions, present greater options for industrial thermal applications and increase the diversity of fuel supplies, hence improve South Africa's energy security. For granting Sasol a monopoly (First Gas), the Government has instituted a price cap on piped gas from Mozambique for the next ten years. It is possible that the piped gas industry will be deregulated after 10 years after the first gas period comes to an end.

6.2.4 Pricing

Sasol Gas uses a market value pricing mechanism. This is defined as equating the price of gas to that of the import parity price of the mix of logical alternative energy carriers as calculated in October each year and is then differentiated on a volume basis. These prices for 2003 are given in Table 33. At high levels of consumption, above 400,000 GJ per annum, prices are negotiated.

Table 33 Price of Sasol Gas in 2003

Consumption, GJ per annum	Price (R/GJ)
0-5000	87.19
5001-15000	79.22
15001-40000	71.57
40001-10000	62.3
100001-400000	54.05
More than 400000	46.2

Trends and developments

With the piping of natural gas from Temane, Mozambique, to Secunda, South Africa, starting from February 2004, the pipelines that transported coal gas from Secunda to CTMM have been converted to transport natural gas. It is envisaged that residential areas will be reticulated to enable them to utilise natural gas.

6.3 ELECTRICITY

Electricity supply in Tshwane is presented in terms of purchases from internal generation and Eskom. The CTMM purchases 90% of the electricity required for the Tshwane area. Two local power stations, Rooiwal and Pretoria West, meet the rest of electricity need in the Tshwane area. The Rooiwal power station consists of 5 x 60 MW coal-burning units. The first unit was commissioned in 1961 and the fifth in 1967. Pretoria West consists of **** units. No IPPs are as yet operational within CTMM.

6.3.1 Electricity Purchases

Supply from Pretoria West and Rooiwal are presented in Figure 44 and Figure 45 below.

Figure 44 Pretoria West Power Station Generation

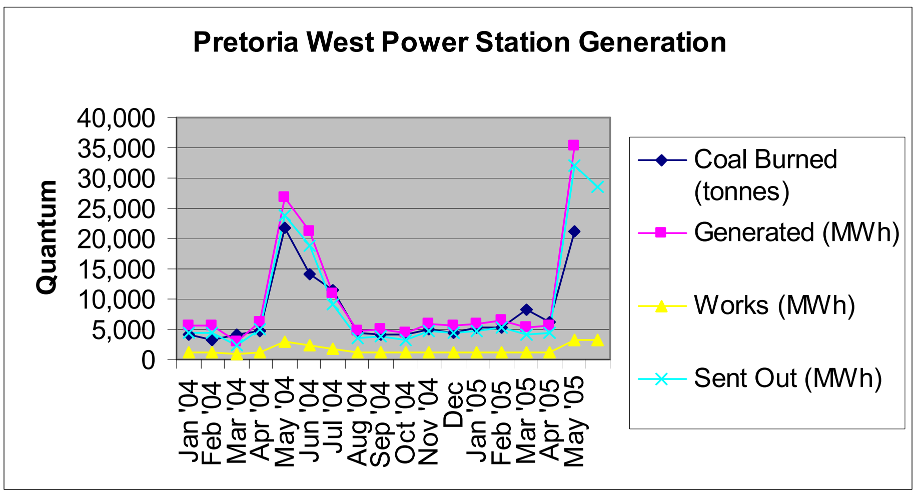


Figure 45 Rooiwal Power Station Generation

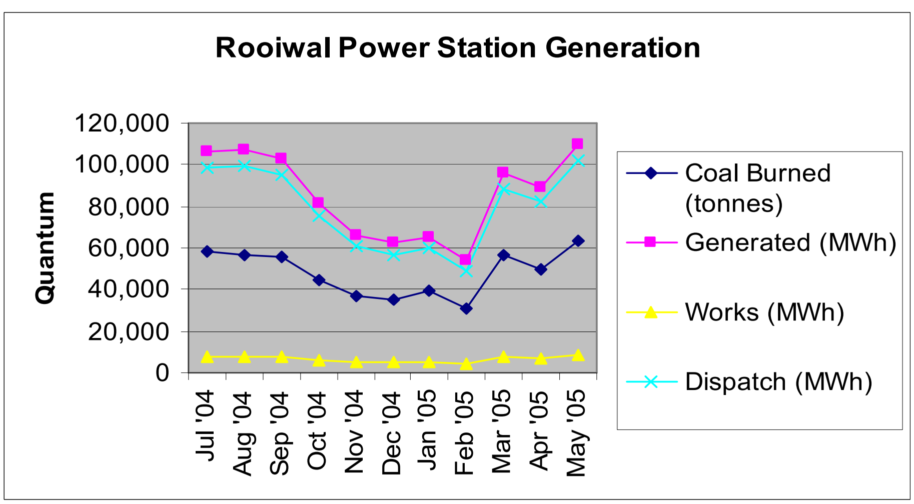
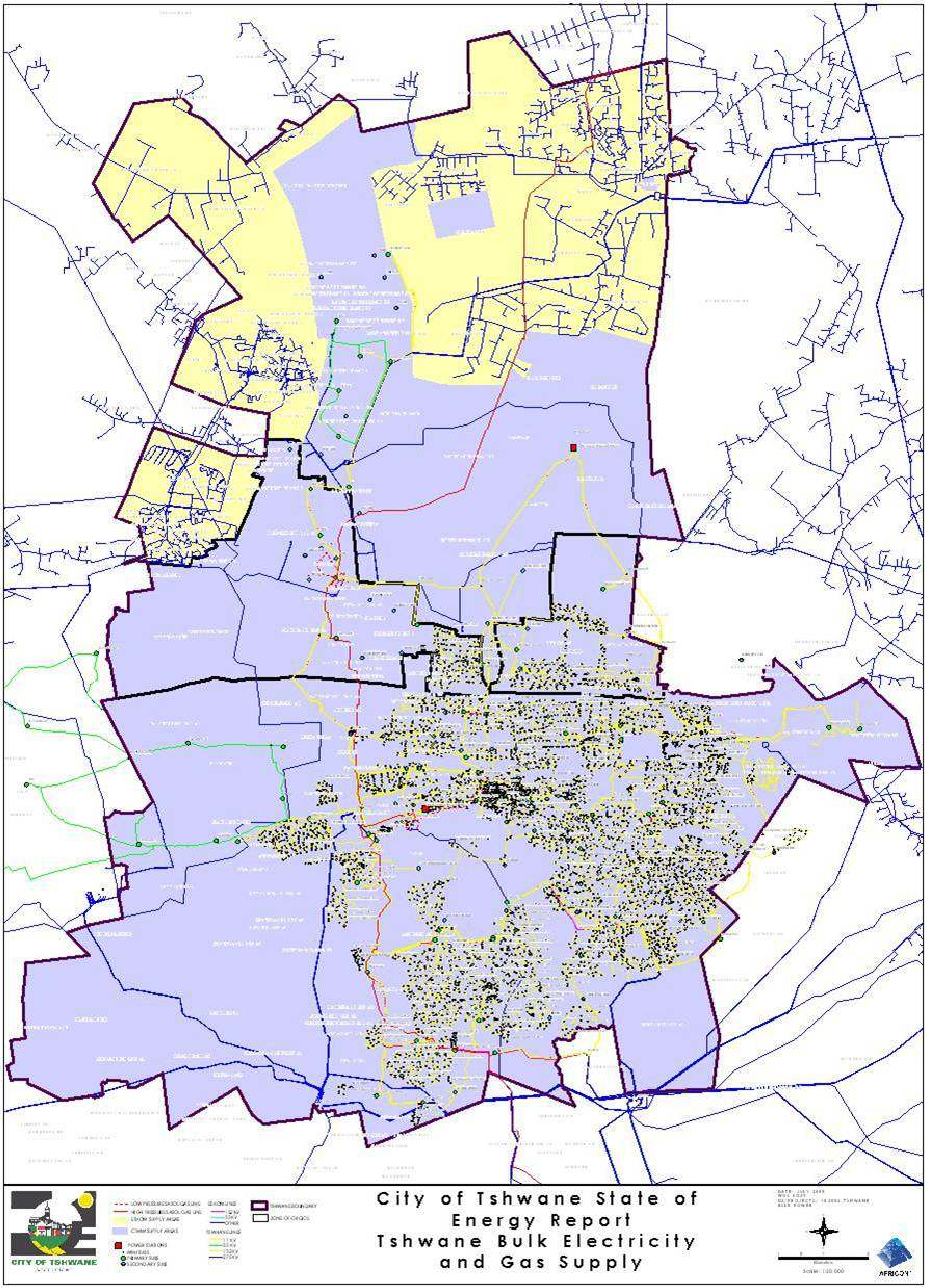


Figure 46 overleaf presents the electricity and gas bulk supply to Tshwane, also indicating the locations of the two power stations, Rooiwal in the northeast and Pretoria West in the central southern area of Tshwane.

Figure 46 Electricity and Gas Bulk Supply to Tshwane



The Electricity Department also purchases electricity from Eskom, as shown in Figure 47 and Table 34 below.

Figure 47 CTMM Electricity Purchases from Eskom (Jan 04-Jun05)

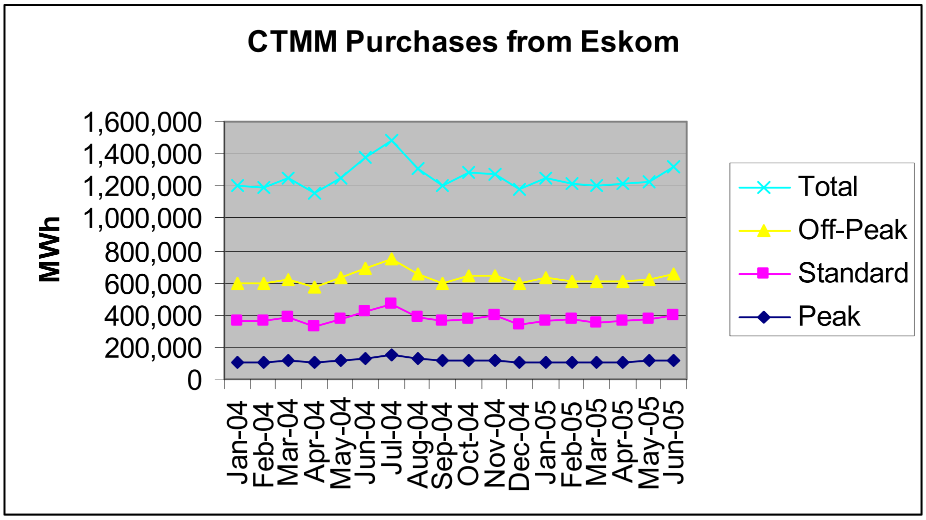


Table 34 CTMM Electricity Purchases from Eskom

MONTH	Peak (MWh)	Standard (MWh)	Off-Peak (MWh)	Total (MWh)	Demand (MW)/(MVA)	Amount (R'000)
04-Jan	104,942	252,708	241,656	599,305	1,139	R 67,099
04-Feb	106,651	250,233	239,532	596,416	1,171	R 69,911
04-Mar	116,354	270,178	236,834	623,366	1,158	R 72,677
04-Apr	99,839	229,715	247,396	576,950	1,208	R 67,037
04-May	113,317	258,621	254,028	625,967	1,303	R 79,776
04-Jun	132,206	289,184	266,036	687,425	1,469	R 138,521
04-Jul	146,636	317,995	279,370	744,001	1,550	R 148,480
04-Aug	122,994	266,536	263,761	653,290	1,420	R 123,460
04-Sep	114,717	252,681	231,725	599,122	1,274	R 72,335
04-Oct	115,065	264,145	260,219	639,428	1,237	R 75,079
04-Nov	120,436	277,136	241,607	639,178	1,210	R 75,230
04-Dec	101,570	241,545	246,691	589,806	1,251	R 67,294
05-Jan	107,483	255,106	262,591	625,180	**1,233**	R 79,964
05-Feb	109,600	258,403	236,654	604,657	**1,293**	R 79,048
05-Mar	103,020	246,257	252,701	601,977	**1,205**	R 77,855
05-Apr	107,458	257,832	244,619	609,909	**1,224**	R 79,176
05-May	115,663	255,997	241,981	613,641	**1,335**	R 84,556
05-Jun	120,599	278,060	259,695	658,354	**1,443**	R 144,493

The installation of power factor correction equipment at the Kwagga and Njala infeed point, which reduces the import of reactive power from Eskom saves Tshwane about R5,9 million annually.

Table 35 shows that CTMM averaged 11.2% own generation up until May 2005. Own generation is expected to increase significantly (as can be seen for the proportion of energy supplied by CTMM in May 2005) with the cancellation of the Eskom – CTMM contract in March 2005 of the Dynamic Surplus Deal, in which Eskom previously accorded CTMM a discount on Eskom generation in replacement of Rooiwal generation. The increased winter demand is expected to put increased pressure on the two power stations.

Table 35 Comparison of Monthly Eskom and Own Generation

Month	Own Generation	Purchased from Eskom
Jan 04	8.90%	91.10%
Feb 04	7.40%	92.60%
Mar 04	10.50%	89.50%
Apr 04	10.90%	89.10%
May 04	13.80%	86.20%
Jun 04	14.90%	85.10%
Jul 04	12.80%	87.20%
Aug 04	13.70%	86.30%
Sep 04	14.20%	85.80%
Oct 04	10.80%	89.20%
Nov 04	9.20%	90.80%
Dec 04	9.40%	90.60%
Jan 05	9.40%	90.60%
Feb 05	8.40%	91.60%
Mar 05	13.30%	86.70%
Apr 05	12.20%	87.80%
May 04	18.40%	81.60%

Source: CTMM Electricity

6.3.2 Electricity network

The CTMM Electricity Department does not currently have an up to date asset register. Most municipalities in South Africa have not developed an asset register, and if they have, it has not been updated recently either in terms of network valuation or condition assessment. Given the requirements of the EDI Restructuring Bill, and the expectation that municipalities will move into a "REDs" (Regional Electricity Distributor) framework, it is expected that ringfencing of the electricity businesses in each SA metropolitan municipality will take place during the course of the next year. This has been done in Cape Town and has been initiated in Ekurhuleni. It is understood that Tshwane Electricity will make a decision shortly on the process for preparing for the REDs, including electricity ringfencing and development of the asset register.

6.3.3 Replacement and net book value

Although an asset register has not yet been compiled, it is possible nevertheless to estimate the network replacement value based on the number of customers within Tshwane. Pending verification of actual network assets and their condition, the NER has accepted an estimate of R10 000 per existing connection, including backbone, as a network valuation measure[20]. Based on the number of customers shown in Table 23, the network value has been (grossly) estimated at R3.9 billion[21].

[20] National Electricity Regulator, South African National Electricity Distribution Infrastructure – Status Report, April 2004 (Africon)

[21] Tshwane City Development Strategy, August 2005 (Africon)

6.3.4 Condition, maintenance backlog and decay rate

CTMM has not recently carried out a comprehensive condition and maintenance backlog assessment for the network. However, specific refurbishment projects have been identified, as shown in Table 36 below.

Table 36 CTMM Electricity Network Refurbishment Budget

Project Category	Budget 2005/2006 (R' 000)
Subtransmission Refurbishment	8 570
Distribution Refurbishment	8 182
Total	16 752

It is understood that those portions of the network for which adequate maintenance funding has been provided are in relatively good condition. However, there is a trend in maintenance funding in CTMM, which should be pointed out. Maintenance in the northern areas of Tshwane is considered by CTMM Electricity to be up to date, as the network is relatively new and maintenance for this area has been well funded over the last few years. Through the wish of the Council to redress historical inequities, maintenance spend has been roughly divided along an 80/20 basis between the more rural, poorer north and the generally wealthier south. This has had the unfortunate consequence of creating an under spend on maintenance for the denser, older, more fragile southern network.

Should CTMM embark on a comprehensive maintenance planning exercise, this should include a thorough assessment of the decay rate of existing infrastructure.

6.3.5 Current and future maintenance, refurbishment and extension programmes

It is understood that there is currently no rolling master plan for network maintenance, refurbishment and extension, although Electricity Department staff carries out forward planning. A three year master plan would provide CTMM Electricity with a "living" document on which to base a dynamic and responsive maintenance programme, assuming its development would be adequately supported by Council and the conclusions implemented appropriately.

Table 37 Planned Electricity Network Extension Budgets

Project Category	Budget 2005/2006 (R' 000)
Subtransmission Capacity	65 940
Distribution Capacity	25 370
Consumer Connections	24 600
Total	115 910

Network extension is typically estimated at R5000 per new connection.

6.3.6 Tariff Adequacy

CTMM's own revenues are heavily influenced by the adequacy of the tariffs as well as historical cross-subsidisation patterns.

Although a detailed review of the cost-reflectiveness of the electricity tariffs has not been carried out under this project, it is understood that the tariff reflects well the load-related elements and that overheads and interdepartmental charges are difficult to measure accurately. It should be noted that an assessment of the adequacy of the tariff would typically be carried out under a so-called Section 78(1) Assessment, that is, an assessment in terms of Section 78(1) of the Municipal Systems Act of the adequacy of an internal mechanism within a municipality to deliver the service required.

6.3.7 Cross-subsidisation

It is understood that CTMM Electricity revenues subsidise a significant share of other CTMM municipal services. Again, since a detailed financial analysis is beyond the scope of this assessment, the conclusions have been presented at a qualitative level rather than a quantitative level.

It should be noted that under the RED dispensation, tariff structures would be harmonised countrywide and electricity would no longer cross-subsidise other municipal services – but the REDs have been set up so that electricity customers from richer areas would subsidise those from poorer areas. The net shift in cross-subsidisation has not been assessed at this point.

6.3.8 Effects of different levels of funding on level of service provided

The current under funding of maintenance to the southern portion of the network will eventually, most likely sooner rather than later, have a backlash effect on quality of service in the northern regions, as network and equipment failure will soon necessitate much higher levels of capital expenditure than those required for regular, scheduled maintenance.

It should also be noted that cross-subsidisation of other municipal services by electricity also severely constrains the effective delivery of electricity services throughout Tshwane.

6.3.9 Policy and regulatory context

These are outlined in Section 2.

6.3.10 Trends and Developments

6.3.10.1 Movement to an external mechanism

Electricity distribution in South Africa is being reorganised from the current municipal responsibility for electricity service delivery to a Regional Electricity Distributor (RED) dispensation. Municipalities in South Africa are currently preparing to join the REDs. This involves, inter alia, evaluation of internal and external service delivery mechanisms in terms of Section 78 of the Municipal Systems Act. Should CTMM ultimately decide in terms of Section 78(3) of the Municipal Systems Act to pursue an external service delivery mechanism, it could open up possibilities for alternative financing mechanisms.

Briefly, a Section 78 assessment involves the evaluation of the adequacy of the current service delivery mechanism (considered "internal") to deliver the required service. Internal mechanism includes the Department and Business Unit models, as well as a category named "other", which the framers of the Act provided to allow for innovation within the internal mechanism. Following the assessment of the internal mechanism, the municipality may decide the internal mechanism is adequate, or may choose to evaluate possible external mechanisms, also provided for in the Act. The REDs are considered external mechanisms.

Although it is a matter of national policy that the REDs will be implemented, there are many steps which must be taken before this happens. The most critical of these is the ringfencing of the electricity business. Furthermore, a Section 78 assessment of the potential service delivery mechanisms must be carried out in terms of the Municipal Systems Act.

6.3.10.2 Formation of the REDs

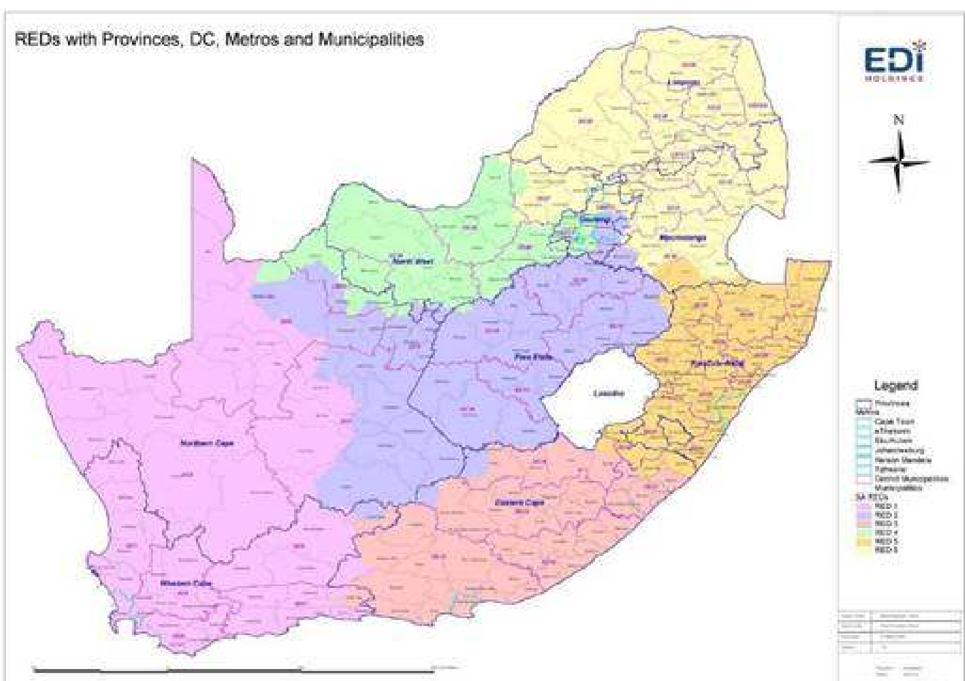
In 1996 government decided to restructure the electricity distribution sector into six Regional Electricity Distributors (REDs) from Eskom Distribution and the current 189 municipal undertakings involved in electricity distribution. The purpose was to introduce competition (choice of supplier) and to achieve a higher level of business efficiency within these larger and more specialised bodies. This in essence means the merger of Eskom and local government distribution in specific areas and the establishment of national tariffs regulated by the NER rather than a host of tariffs charged by Eskom and the municipalities.

One of the key preparatory activities has been the ringfencing of electricity from other municipal infrastructure service functions, such as water and waste management.

Slow but steady progress had been made and in 2003 government set up the EDI (Electricity Distribution Industry) Holdings Company with the intention of incorporating all distributors within it and then rolling each RED out as an independent unit as soon as this is possible. The initiative has led to uncertainty and confusion within the electricity distribution sector, resulting in a "wait and see" situation wherein investment and new initiatives are being kept on hold until this action has been completed. However, EDI Holdings is now starting to secure commitments from municipalities with respect to the conversion to REDs.

Tshwane will become part of RED 6, as shown in Figure 48, and is currently evaluating the details of its rollout of the REDs strategy.

Figure 48 REDs Boundaries



RED 1, which will encompass the Western Cape and Northern Cape Provinces, is became operational 1 July 2005.

6.3.10.3 Energy Efficiency and Demand Side Management (DSM)

In addition to "classical" sources of funding (own revenues, Municipal Infrastructure Grant and DME electrification fund) the energy sector presents further opportunities for municipal energy savings through national initiatives such as energy efficiency (EE) and demand side management (DSM). It is anticipated that municipal targets will be set at the national level, and that these would be incentivised.

Local electricity departments will have to become directly involved in the efficient use of electricity in future. This will result from the draft energy efficiency strategy of government and the draft policy of the NER on regulating energy efficiency and DSM activities. The policies will most probably lead to local policies and programmes linked to national programmes. It will require that energy efficiency and DSM plans be developed and approved by the NER in order to share in national funding for this purpose. It is also possible that these activities may become a dedicated component of the integrated resource plan that the NER anticipates requiring of all distributors.

6.3.10.3.1 DSM initiatives in CTMM

Eskom DSM is currently rolling out an efficient lighting initiative in Ga-Rankuwa, aiming to fit some 35 000 households with energy efficient lighting in 2005.

6.3.10.3.2 Illegal connections

Tshwane is subject to illegal connections (theft of electricity), which generally occur when a customer has been cut off for non-payment. Illegal connections, a component of non-technical losses, are also a side effect of payment boycotts, in the sense that some of the population believe that electricity should be provided free, especially to lower income groups. The impacts of illegal connections are:

- The cost of distributing electricity is not adequately covered by revenues, placing pressure on the revenue cycle
- Too much current may be drawn at one location, causing protection systems to be activated and loss of supply or reduction in quality of supply to neighbouring customers
- Possible injury or death by electrocution for the person carrying out the illegal connections – and these are often children, since their hands are small enough to reach into the enclosed spaces of the switchboxes.

6.3.10.3.3 Vandalism

Cable theft and vandalism of electricity infrastructure does not only result in a need to replace equipment with the corresponding capital outlay, in some cases it also results in a loss of service to the area served through the cable. Because these crimes usually occur at night and repairs can only be effected during the day, customers in an affected area experience power cuts during peak morning hours before the day shift can remedy the situation.

The impact of conductor theft is therefore multiple:

- Loss of reliable power supply, often during peak hours, with associated impact on customers' perception of quality of service
- Diversion of labour to repairs rather than preventive/scheduled maintenance
- Funds which would otherwise be available for e.g. network improvements or job creation must be used to restore the network
- Vandals expose themselves to an extremely high risk of electrocution.

6.3.11 Gaps, constraints and issues

The process of ringfencing and rationalisation of the electricity activities of CTMM is in process. There are some inconsistencies between supply and consumption data, which will be addressed to the extent possible with the relevant CTMM and Eskom personnel as the study progresses.

6.4 COAL

Supply of coal within Tshwane is summarised in Table 38 below.

Table 38 Coal Supply in Tshwane

Coal Suppliers	Supplied per period (tonnes)	Period	Estimated Annual Supply (tonnes per year)	Consumers
Kumba Resources	2,009	For 2004	2,009	Rooiwal Power Station
?	9,448		9,448	Pretoria West Power Station
Xtrata Coal	2,000	Average per month	2,000	Brian BBQ Int.
Anglo Coal Collieries				
Goedehoop	103,082	Jan – May '05	206,164	
Greenside 2004	309,357	For 2004	309,357	Rooiwal Power Station
Landau	300,000	For 2004	300,000	Rooiwal Power Station
?	80,000		80,000	Pretoria West Power Station
McPhail	12,000	Average per month	144,000	Coke, PPC, ADB
Chandler	3,000	Average per month	36,000	SAB Roslyn
TOTAL:	820,896		1,088,978.00	

There are some eight suppliers of coal in Tshwane:

Total coal supplied to CTMM in 2003 was 820 896 tonnes for industry, commerce and households. The suppliers requested confidentiality as to the volume of their annual sales. These suppliers take orders from clients and source the coal directly from the pitheads (mines) and supply at the premises of the clients. However few suppliers keep marginal stockpiles at their premises to meet certain ad hoc requests. Some of the suppliers have depots in CTMM.

The price of coal depends on distance from pithead to the premises of the client, the grade of coal and obviously the tonnages required. On the whole, prices range from R180-R500 per ton. The coal is supplied in 70 kg bags, in trucks with capacities of 10-30 tons, in scoops or grabs (720 kg). The clients are commerce, industry and smaller merchants who retail the coal.

6.4.1 Policy and regulatory context

The coal industry is deregulated and the price of coal is not regulated at the retail level. The DME has published terms of reference for appointing a consultant to review the coal industry. At the level of sales of coal to Eskom, pricing regimes are negotiated between Eskom and the supplier on contractual basis.

6.5 RENEWABLE ENERGY

Progressive governments and municipalities the world over are embarking on robust renewable energy measures. Reasons for embracing renewables include the need to diversify energy supplies and protect the environment from generation, transportation, distribution and transportation of energy, as well as to address inequities in energy service provision.

With respect to South Africa, the government is taking renewable energy very seriously. At the national level, progressive policies and legislations are being formulated, and strategies are mapped out as described in Section 2.4.3. Municipalities are entities that are tasked to translate the policies into local and action plans, or have to ensure that the national policies are implemented. National renewable energy strategy will not be realised if municipalities are not sufficiently capacitated to lead the way.

A list of renewable energy suppliers is provided in Annexure 2, along with contact details. Several of these businesses are located in Tshwane.

6.5.1 Traditional biomass energy

Traditional biomass fuels are, by definition non-commercial and renewable fuels, such as animal waste (animal dung) or crop residues. Of all household energy carriers, animal dung is the least commercial and monetised.[22]. The use of traditional biomass is insignificant in percentage terms vis-à-vis other fuel sources. However, its use in certain pockets of Tshwane is still dominant, as shown in Figure 25 through Figure 27.

6.5.2 Woodfuel

Little woodfuel is used in Tshwane relative to electricity, gas, IP and coal. This appears normal, as the rural and peri-urban areas of Tshwane are essentially deforested, with limited access to “free” woodfuel as in more protected rural areas. The little woodfuel used in the poorer areas is only confined to heating and cooking by destitute households. There is some that is used more for recreational purposes (such as braais) and in traditional ceremonies. The household survey is expected to shed more light on the patterns of household use of woodfuel in Tshwane.

[22] According to the Census, some few households in Tshwane use animal dung mainly for heating and cooking. In rural areas, animal dung also has a non-energy use for the plastering of huts in rural areas.

6.5.3 Modern renewable energy

Generally renewables do not feature much in South Africa's energy mix. Currently, energy derived from RE is approximately 6% and 10% if biomass energy is included. Most of the renewable energy use is outside the Tshwane Metro, in rural areas and in the west coast of the country.

There are few significant or large-scale RE or EE projects in Tshwane. Some of the disincentives of EE and RE measures include the widely available and cheaper coal-based electricity, as well as the well-defined transport network to distribute petroleum products. CTMM is essentially an urban and lightly industrialized municipality. All formal households, and some areas within informal settlements, are connected to the national grid. Low-income households generally rely on a combination of energy types depending on specific end-uses. Coal, paraffin (IP) and LPG are generally fuels that are used with electricity for thermal applications, while electricity is used with IP and candles for lighting. There has been some effort to encourage alternative RE sources for these end-uses, as evidenced by the demonstration projects described below.

6.5.4 Tshwane Renewable Energy / Innovative Energy Projects

Tshwane has initiated several projects involving renewable energy, energy efficiency and innovative energy solutions. Some of these are being guided by members of the SET Committee and/or members of the non-conventional working group.

- ***The Babelegi Industrial Site Project*** boasts the planting of trees serving in the sequestration of carbon, which result from the use of fossil fuels and is a common denominator in the debates on climate change.
- ***The Balebogeng Primary School "Greening" Project*** has been completed and handed over to the school governing body. The project addresses issues of renewable energy, energy efficiency, conservation of natural resources and climate change. This project has demonstrated to the Mamelodi Community some of the energy technologies such as solar water heating systems, solar cookers and energy saving bulbs, etc. The project is part of the Cities for Climate Protection (CCP) Campaign. This also applies to the Mini-Munitoria (Lefatshe) Project in Atteridgeville which is due for completion by the end of 2005. These projects are all funded by the International Council for Local Environmental Initiatives (ICLEI).
- ***The LP Gas pilot project in Winterveldt*** was developed as an alternative to the free basic electricity received by households connected to the grid. 500 households have been identified and the service provider, Easigas has been appointed. Each household is given a once off subsidy in the form of a gas cylinder and a monthly gas refill equivalent to 50kWh. The provision of LP gas in this serves as a tool to eliminate the use of paraffin associated with poisoning and shack fires. Additionally, gas is one of energy efficient alternatives as it is a cleaner fossil fuel.
- ***The "Greening" of the 2004 International Pretoria Show*** was done through the retrofit of light bulbs in Hall C of the Show grounds. These light bulbs were replaced by energy-saving bulbs. A stand on sustainable energy was also hired for the duration of the show.
- ***Bontle ke Botho Project:*** This project forms part of the 2004/2005 energy themes, a competition run by Gauteng's Department of Agriculture, Conservation and Environment which aims at encouraging cleanliness and care of natural resources in the communities. It was rather vital for the Tshwane Municipality to canvass for energy projects in order to be identified by participating wards and schools. This participation in energy and the environment initiatives has been broadened during the running of the project in 2005.
- ***The 50kWh Houses project,*** currently at the stage of development, ensures that the free basic electricity provided to households by the Governments can be more effective and beneficial if household equipment are at a good state of repair and the principle of energy efficiency is

adhered to. The project is part of the Mutual Learning Project, a product of an agreement between the CTMM and Switzerland.

- Another project at the stage of development is run by ***Waste Management Division of the CTMM***. This project involves generation of electricity from methane gas from the landfill sites and power can be used in the small industrial areas. The World Bank is facilitating the project.
- ***Schools project*** – this project involves installation of solar panels in schools, in collaboration with the 'Adopt a School Foundation'.
- ***LEDs for traffic lights*** – initial project evaluation has not proven positive.
- ***Environmentally Friendly Buildings for the City of Tshwane*** – this project involves retrofitting of all CTMM buildings in collaboration with Eskom.
- ***Algae-x Fuel Conditioner*** – is a company that makes fuel conditioners that can be fitted to diesel engines – which in turn makes the vehicles more fuel-efficient. Emissions can be reduced; project marks the reduction of greenhouse gas emissions particularly from vehicles, which in turn performance improved and the lifespan of a vehicle prolonged. The Tshwane Electricity Department is exploring project implementation on its fleet.
- ***Geyser Control Project*** – 14 houses were included in the pilot study. The next phase which is currently underway is to install the equipment in 250 houses across the city.
- ***Electricity Consumption Monitoring Equipment*** – this project would involve installation of the monitoring equipment to enable customers to monitor electricity consumption interactively.

6.5.5 Household Energy Survey

Analysis of the results of the survey is continuing and was expected to be completed by 1 November at time of preparation of this report.

The following are the partial results from those surveys and questions analysed so far. As the above table shows, these results come entirely from low-income areas of the city and the results reflect this fact. Numbers in the far left columns of the following seven tables represent the number of the question on the survey.

Table 39 Household Characteristics

Household characteristics	TOTAL
1. Total households surveyed	2,343
2. Total persons in households	11,038
3. Average household size	4.7
4. Smallest household	1
5. Largest household	19

Table 40 Monthly Income

Monthly Income:	TOTALS	Per Cent
6. Less than R1000:	489	20.9%
7. R1 000-R4 999:	1299	55.4%
8. R5 000-R9 999:	181	7.7%
9. R10 000-R19 999:	35	1.5%
10. R20 000-R29 999:	0	0.0%
11. R30 000-R49 999:	2	0.1%
12. R50 000+:	6	0.3%
13. Did not answer:	331	14.1%

Table 41 Type of Housing

Formal vs Informal Housing			
14.	Formal:	1843	78.7%
15.	Informal:	458	19.5%
	Did Not Answer	40	1.7%

Table 42 Metering

Metering	TOTALS	Per Cent
16. Meter attached to house?	1881	80.3%
17. Prepayment?	1465	62.5%

Table 43 Type of Energy Used

Type of energy used	Total	Per Cent
18 Electricity	1989	84.9%
19 Coal	409	17.5%
20 Paraffin	1438	61.4%
21Gas (bottled):	489	20.9%
22 Gas (piped):	377	16.1%
23 Firewood:	546	23.3%
24 Candles:	1342	57.3%

Table 44 Household Energy Expenditure

Expenditures on Energy	*Total Expenditure*	*Average Expenditure*
33. Electricity	R518,178.00	R 223.55
34. Coal	R 28,157.00	R 11.56
35. Paraffin	R 70,693.00	R 29.79
36. Gas (cylinders)	R 9,000.00	R 3.84
37. Firewood	R 664.00	R 0.28
38. Candles	R 19,946.00	R 8.46
39. Other	R 1,331.00	R 3.86

Table 45 Energy Supply Perceptions

Energy Supply Perceptions	Totals		Percentages	
	Yes	No	Yes	No
40. Is electricity too expensive?	1837	262	87.5%	12.5%
41. Are cut-offs a major problem?	1752	356	83.1%	16.9%
42. Need better access to wood?	441	1605	21.6%	78.4%
43. Problems with air pollution?	1585	653	70.8%	29.2%
44. Fuel use causing health problems?	1581	620	71.8%	28.2%
45. Does household receive the FBE grant?	1076	1038	50.9%	49.1%

6.5.5.1 Solar power

Most areas in South Africa average more than 2,500 hours of sunshine per year. Average daily solar radiation levels range between 4.5 and 6.5 kWh per square meter. The annual 24 hour global solar radiation average is about 220 Watts per square meter for South Africa, compared to about 150 Watts per square meter for parts of the United States and about 100 watts per square meter for Europe. A solar equipment industry has begun to take root in South Africa – the annual photovoltaic (PV) panel assembly capacity totals 6 MWe and there are also a number of companies that manufacture solar water heaters (SWH).

Partly because of readily available electricity, there has not yet been a concerted effort in the Tshwane municipality to encourage the use of this energy source. The census shows some minor penetration of solar energy, but these remain isolated, with private companies taking the lead on implementation.

There is potential in CTMM to roll out both active and passive solar solutions to provide affordable energy and contribute to demand side management. Passive solar designs for building, particularly in the lower end of the housing market, can significantly reduce energy expenditure for heating. Also, solar home PV and SWH systems can be realistically implemented in the short term.

The major stumbling block of solar energy relates to the costs of the systems, which remain uncompetitive when vis-à-vis competing energy types (paraffin, coal, gas and electricity). A CTMM-based solar company, Sunstove, states good quality stoves cost between US$20 and $40 in the market, the cheapest costing $5 (Sunstove 2004).

6.5.5.2 Biogas energy

It is certain that CTMM generates waste streams and this implies the potential biogas fabrication from these sources needs to be considered for possible renewable energy beneficiation. There are no effective existing biogas initiatives that were reported at the CTMM during the course of this study. However, there is an ongoing survey investigating the viability for biogas production from agricultural sector within the area. Few biogas initiatives exist in South Africa, especially in the rural areas.

Disposal of waste by landfill is the most cost-effective method of waste disposal in South Africa. It is estimated that over 95% of waste generated in South Africa is deposited in landfills. The decomposition of waste in a landfill leads to the release of landfill gas (LFG). This biogas contains predominantly carbon dioxide (CO^2) and methane (CH_4). The uncontrolled release of LFG emissions give rise to environmental and health problems such as odour nuisance, global warming, etc. This gas can be recovered for energy beneficiation since it contains more than 50% methane, instead of releasing it into the atmosphere.

The CTMM currently operates 9 regional landfill sites, as shown in Table 46 below.

Table 46 Solid waste quantities handled at CTMM landfills

LANDFILL SITE	Year open	Lifetime	Average tonnage per month	Building %	Garden %	House-hold %	Industrial %
Kwaggasrand	1965	5-7 years	16 000	10	20	60	10
Valhalla	1975	2 months	18000	10	20	60	10
Garstkloof	1980	5 years	22 000	30	60	5	5
Derdepoort	1997	3years	18 000	20	70	5	5
Onderstepoort	1997	20-25 years	17 000	10	20	70	10
Hatherley	1998	50 years	12 000	10	20	60	10
Ga-Rankuwa	1995	20-25 years	15 000	10	10	60	20
Soshanguve	1995	10-15 years	11 000	5	10	80	5
Temba	1995	6 –12 months	8 000	10	10	70	10
TOTAL			137 000				

Source: CTMM Solid Waste Management

6.5.5.2.1 Energy potential from CTMM landfills

LFG utilisation options include:

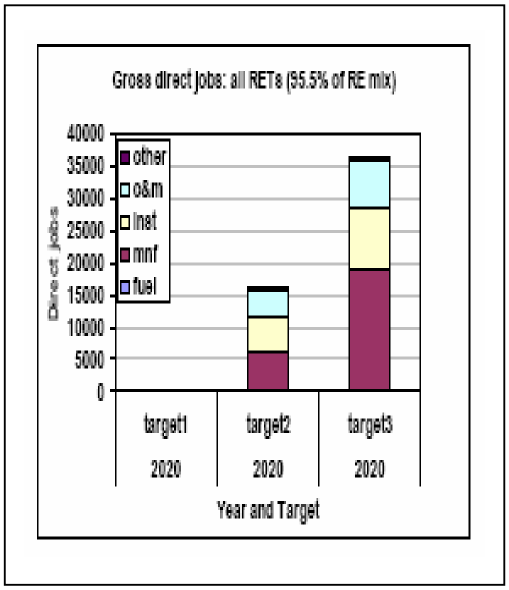
- Flaring only: flaring means the burning of the LFG.
- Using as boiler gas: this option is limited due to distance between boiler users and the landfill sites. However, such an option exists next to the Rietfontein site where there is a tile/brick factory.
- Electricity generation
- Vehicle fuel: methane gas can be used as vehicle fuel in two methods as: a) clean methane and; b) Mixed with diesel (25% diesel and 75% methane).

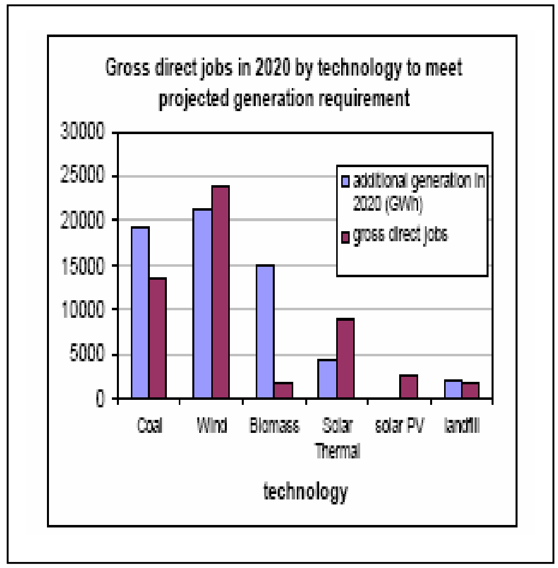
An example of an electricity from landfill gas project in eThekwini is shown in Annexure 3

6.5.5.3 Employment Potential for Renewable Energy

Data on renewable energy are scarce in South Africa. The only recent and notable works in this are reports by Stassen (2001) on solar PV, solar thermal, wind, biomass, and anaerobic digestion (landfill gas), as well as a study on renewable energy employment potential (Agama & SECCP 2003). The latter study demonstrates that large-scale deployment of renewable energy technologies could sustain and increase the number of jobs particularly in local manufacturing of technologies, as illustrated in Figure 28.

Figure 49 Potential in different renewable energy technologies (RETs)





The figures above refer to the national situation and it is not known the extent to which renewables provides job opportunities in the CTMM. However, it is assumed that the low deployment of RE technologies militates against RE contributing to the municipality's GDP.

6.5.6 Information and data gaps

The census reveals high use of solar energy and other renewables, yet there is little data to substantiate this high use. This information gap needs to be addressed.

6.5.7 Pricing

Data on pricing of RE technologies and components within CTMM was difficult to obtain. This may due to the fact that there is no widespread deployment of these RE technologies in CTMM.

In general, it is known that solar power for electricity is expensive in terms of capex per kW installed related to other renewable sources of electricity, such as wind power or mini-hydro. This is due to the cost of the panels and the cost of the batteries needed to store energy for periods of darkness or low sunshine. Furthermore, solar panels are vulnerable to theft and vandalism.

In terms of operation costs (measured in R/kWh), solar power is competitive with other renewable electricity solutions, although battery replacement can represent a barrier to sustainability.

However, solar water heaters are more economically viable.

6.5.8 Trends and developments

The RE and EE strategies are expected to be taken into account in municipalities' action plans from 2005 onwards. It is expected that until renewables and energy efficiency become part of the CTMM IDP, there will be little change from the current status quo of low renewable use. Both strategies emphasise the implementation of economically viable and technologically proven renewables.

Given the availability of installers (plumbers) and small manufacturing plants in CTMM, it is envisioned that the rollout of solar water heaters would be a short to medium term objective for a municipal energy strategy.

6.6 ENERGY EFFICIENCY IN CTMM

Undertaking energy efficiency measures is a win-win situation as far as energy savings are concerned. The consumer is able to obtain maximum (energy) output from a minimum input, thereby savings scarce monetary resources. The utility is able to effectively undertake its load management, thereby delaying decisions for building additional power station. At the low-income end of the market, the real energy savings can be made in the field of space heating. Installing an insular-integrated ceiling in brick houses in Gauteng would, for instance, save up to 90% of energy consumed for heating during winter (Mathews 1995). Stringent implementation of demand side management could offset the forecast shortage of excess capacity (ref Section 1.4.1) through generation of “negawatts”.

6.6.1 Overview of the energy efficiency objectives

Generally, the aim of energy efficiency programmes in South Africa is to mitigate against greenhouse gas (GHG) emission in the electricity sector through reduction of coal-based generation. For energy efficiency strategies to achieve their intended goal, they should be robustly implemented across all important economic sectors: residential, commercial, industrial and public buildings (health care, street lighting). However, for EE programmes to reach targets of minimum energy emission, they should serve socio-economic goals as well. Other benefits, such as the reduction on electricity costs in large commercial and industrial plants, lowering of energy costs at the household level and creation of employment and economic benefit arising from energy efficiency market, should be highlighted.

6.6.2 Energy efficiency programmes in CTMM

An aggressive marketing campaign is underway to inform customers on energy efficiency matters. The sizable budget is expected to be disbursed before 1 July 2005.

6.6.2.1 Efficient Compact Fluorescent Lamp (CFL)

The South African component of the Efficient Lighting Initiative (ELI, an IFC supported programme) aims to penetrate the South African market with 32 million Compact Fluorescent Lamps (CFLs) over the next decade and a half. If the above target is met, the efficient lighting programme could save the environment in the order of:

- CO2 emissions – 3.6 Mt/year
- SOx emissions – 29.4 kt/year
- NOx emissions – 14.65 kt/year
- Water use – 4.8 Gl/year
- Coal use – 1.92 Mt/year
- Ash produced – 505 kt/year

Energy efficient CFLs last up to ten times longer than incandescent lamps and use up to 75% less energy, which translates into reduced electricity bills for consumers. Whereas an ordinary incandescent light bulb would produce 1 000 hours of light lasting on average four to five months, a quality compact fluorescent lamp will provide 10 000 hours of the equivalent amount of light and last approximately eight years (Table 37).

Table 47 Technical comparison between the 60-Watt incandescent lamp and the 15-Watt CFL

PARAMETER		60 WATT INCANDESCENT LAMP	15 WATT CFL
Wattage (W)		60	15
Monthly consumption (kWh)		7,2	1,8
Equivalent incandescent lamp light output (W)		60	75
Expected life (4 hours daily use)	Hours	1,000	6,000 – 15,000
	Years	0,68	4,11 – 10,27
Price		R 3.00	R 20.00 – R 80.00
Manufacturer guarantee (years)		NONE	1-3
Burning surface lamp temperature		Very high	Low

Source: Bonesa 2003

Eskom DSM and Bonesa together with the electricity department of CTMM have implemented an Efficient Lighting Initiative (ELI) using mostly CFLs for low income households, CTMM buildings and public lighting.

Eskom DSM are currently rolling out a CFL programme in Ga-Rankuwa, starting with a household survey being administered to some 32 000 households in the community over the period June-August 2005.

6.6.2.2 Residential load management

No specific residential load management activities were identified in CTMM.

6.6.3 EE business in CTMM

A list of Energy Services Companies (ESCOs) providing DSM advice to businesses is available from Eskom DSM.

6.6.4 Information and data gaps

The following information and data need be acquired from CTMM and solar industry:

- Industries and commercial sectors' own DSM activities
- The results of the recently implemented DSM programme which focuses mainly on replacing conventional lighting with CFLs.

6.6.5 Future trends in REEES

The adoption of the Energy Efficiency strategy will provide the impetus for coordinated initiatives to implement EE measures. Like the RE strategy, this strategy first articulates the energy efficiency targets, as well as implying the role of municipalities in achieving these. As a significant consumer of energy, the CTMM is expected to lead the way in articulating its own demand-side management measures.

6.7 ENERGY PRICING IN CTMM

Table 50 provides a good indication of the reasons for the preferences for IP and coal in low-income households. LPG is deemed expensive and used by those in relatively high-income strata. However, most of the use of coal occurs in winter, when a relatively cheap source of energy is required for space heating. It is interesting to note that cost per unit energy of LPG is similar to that of electricity.

Table 48 Comparative prices of household energy carriers in Tshwane, 2004

Energy Carrier	Price per Unit Energy, Rand/MJ	% Relative to LPG price
LPG	0.10	100
IP	0.08	80
Coal	0.02	20
Electricity	0.10	100

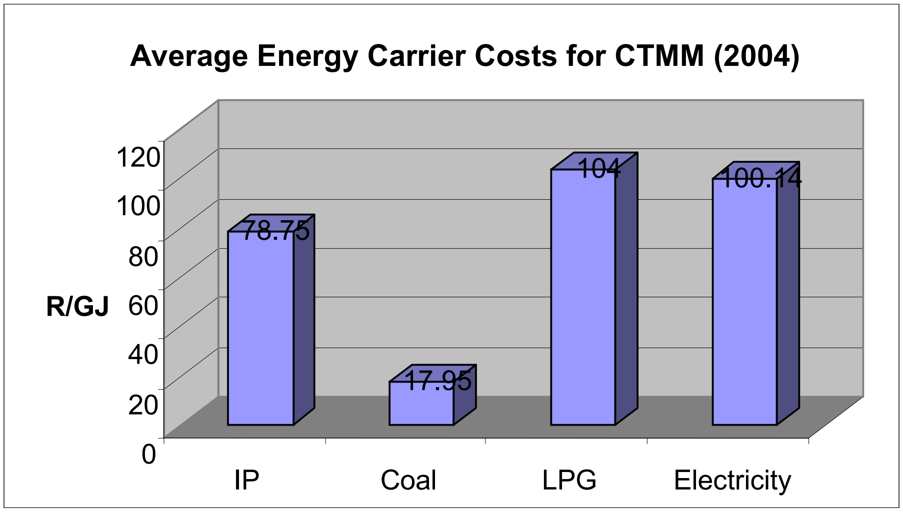
6.7.1.1 Energy costs

Energy costs have been estimated from a combination of historical survey and inflation data. Per unit price paid for various energy carriers varies according to location, transportation costs and mark-up tolerance. Table 49 shows average energy costs over time, and Figure 29 shows average energy costs in CTMM for 2004.

Table 49 Estimated average energy carrier costs for Tshwane

		1992	1992	1992	1992	2004	2004	2004	2004	2004	2004
		Supplier Purchase Price	Supplier Sales Price	Retailer Purchase Price	Retailer Sales Price	Supplier Purchase Price	Supplier Sales Price	Retailer Purchase Price	Retailer Sales Price	R/MJ	R/GJ
IP	(R/l)	0.82	0.93	0.95	1.36	1.76	1.99	2.04	2.91	0.08	78.75
Coal	(R/t)	66.7	110.4	136	203.6	142.90	236.52	291.36	436.18	0.02	17.95
LPG	(R/l)	0.75	0.98	0.92	1.296140032	1.60	2.10	1.98	2.78	0.10	104.00
Electricity	(R/kWh)								0.3605	0.10	100.14

Figure 50 Average energy carrier costs for CTMM (2004)



6.7.1.2 Best mix of energy and appliances

In rural and peri-urban areas, particularly where affordability is an issue, it is useful for municipal planners to develop, in collaboration with local communities, a preferred mix of energy and appliances from the consumer's perspective – an "Acceptability Matrix" – to optimise environmental, health, safety and socioeconomic factors. An example of such a matrix is provided in Table 50 below.

Table 50 Acceptability Matrix for Energy/Appliance Combinations

ENERGY CARRIER	COOKING	WATER HEATING	SPACE HEATING	LIGHTING	ENTERTAINMENT	REFRIGERATION
Electricity	g	g	a	g	g	g
IP	a	i	a	I	I	a
Woodfuel	a	i	a	i	i	
Coal	i	i	i	i	i	I
Animal dung	i	i	i	i	i	i
LPG	g	a	g	i	i	a
Candles				a	i	

g = good

a = acceptable

i = inappropriate

The exercise of developing such a matrix provides a useful basis for awareness building around the health, safety, and environmental and other impacts of various energy options.

7. ENVIRONMENTAL/HEALTH ISSUES RELATING TO ENERGY IN CTMM

7.1 INTRODUCTION

The generation, transportation, distribution and use of energy are the major driving forces of environmental change in the City of Tshwane Metropolitan Municipality (CTMM). CTMM largely relies on electricity for its energy requirements. Industry and business account for approximately 43% of the electricity consumption, domestic consumption a further 40%, with commerce consuming 15% (ref Table 9). A large proportion of the electricity in the area is supplied by Eskom and is dependent on the burning of fossil fuels. Figures 9 to 11 showed the sources from which households derive energy required for lighting, heating and cooking, confirming that CTMM household energy use is very much electricity and therefore fossil fuel based.

7.1.1 Emissions

Fossil fuel combustion produces carbon dioxide, which absorbs radiant energy, contributing to the greenhouse effect. There is concern that increasing concentrations of greenhouse gases (including carbon dioxide, methane and manmade chlorofluorocarbons) may enhance the greenhouse effect and cause global warming. Fossil fuels currently provide nearly 38% of net domestic electricity generation by electric utilities, which contribute to emissions of various gases at significantly high levels into the atmosphere. Estimated emissions from fossil-fuelled steam-electric generating units are:

- Sulphur dioxide (SO_2);
- Nitrogen oxides (NOx); and
- Carbon dioxide (CO_2).

Other major air emissions include:

- volatile organic compounds (VOCs);
- carbon monoxide,
- lead, and
- Particulate matter less than 10 microns in diameter (PM10).

There is growing recognition that these emissions adversely impact the environment locally, nationally, and globally. These impacts are labelled environmental “externalities”. Included in the generic term externality are benefits or costs resulting as an unintended by-product of an economic activity that accrue to someone other than the parties involved in the activity. As a result, externalities do not enter into the market-pricing calculations of the parties undertaking the activity. In the case of power generation, only costs associated with providing electricity are taken into account to the exclusion of costs related to the unintended by-products of producing electricity. Included in this category are the costs of impacts on the ecosystem and the environment, such as human health, which is not fully included in the market price. Due to the fact that these impacts remain unaccounted for, the cost of power generation remains lower than it otherwise would be, if the cost of burdens imposed on society were also included.

Since the early 1970s, the realization that the environment consists of resources that are scarce and exhaustible has brought about a nexus between the environment and the economy. There has been an interest in correcting the prices by including part or all of the excluded costs. Considerations of environmental externalities have thus become increasingly important in the resource planning operations of domestic electric utilities, especially in regard to the use of fossil fuels which impose real and substantial damage to human health and the environment.

7.1.2 Potential impacts of energy on environmental change

The potential impacts of energy on environmental change include, but are not limited to:

- Depletion of non-renewable resources, i.e. fossil fuels
- Increase in atmospheric concentrations such as carbon dioxide, sulphur dioxide, carbon monoxide and lead (amongst others) and these have an adverse impact on health and the natural environment, especially air
- These greenhouse gasses also have an impact on climate change
- Energy is also a major driver of modern economies
- Fossil fuel combustion increases the entropy of the planet, due to the generation of heat as a waste product and this may alter microclimates, e.g. the atmosphere over industrial cities is hotter than rural surroundings.

7.2 ELECTRICITY RELATED ENVIRONMENTAL AND HEALTH ISSUES

7.2.1.1 Air Quality

Use of coal by South Africa's industrial sector is the primary source of the country's air pollution. Several industrial centres, such as South Durban, the Vaal Triangle and Milnerton in Cape Town are considered air pollution "hotspots". More than 90% of South Africa's electricity is generated from the combustion of coal, which contains approximately 1.2% sulphur and up to 45% ash. Coal combustion can lead to particulate matter in the air, as well as contribute to acid rain. Despite harmful environmental effects, coal-fired power stations are not required to use coal scrubbers to remove sulphur, as use of clean-coal technology would significantly raise the cost of electricity for consumers. In addition to power generation, coal combustion in stoves and coal-heated boilers in hospitals and factories contribute to a low-level coal-related atmospheric pollution. In addition to coal combustion, vehicular emissions also contribute to air pollution in urban centres.

The effects of pollution caused by use of leaded gasoline (as South African refineries do not produce high octane unleaded gasoline), use of older vehicles and lack of emissions control technology has been compounded by the absence of vehicle emissions legislation.

Lastly, small waste coal dumps and other hazardous waste from energy-related industries cause both pollution and safety problems and waste coal can spontaneously ignite.

Reliance on coal-based energy sources explains South Africa's proportionally larger carbon dioxide emissions in comparison with many other industrialising countries. Over the past 25 years, primary energy consumption in South Africa's residential and commercial sector has risen only gradually. The slow increase of primary energy consumption in the residential sector can be attributed partially to South Africa's reliance on fuelwood, a non-commercial energy source, which therefore unaccounted for in primary/commercial energy consumption estimates. Fuelwood is still the largest source of household energy in remote rural populations, estimated to meet the daily energy needs of more than one third of South Africa's population. Use of fuelwood is believed to contribute to deforestation in South Africa and is frequently burned in enclosed spaces without adequate ventilation. This results in harmful levels of pollutants in rural homes, increasing the risk of respiratory health problems and other ailments.

7.2.2 PCBs

Until the toxic nature of polychlorinated biphenyls, or PCBs, was discovered, they were used as coolants and lubricants in electrical equipment, particularly transformers. PCBs are a group of synthetic oil-like chemicals, which are particularly stable and were thus appreciated for their insulating capacity. They are part of the family of pollutants known as Persistent Organic Pollutants (http://www.chem.unep.ch/pops/), related to dioxins and furans, which do not break down in the environment. They were taken off the US market in 1977. In addition to transformers, products, which may contain old PCBs, include capacitors, ballast in fluorescent lights and old microscope and hydraulic oils.

The health impacts of PCB exposure include skin conditions, liver damage and possible effects on the immune system. The EPA and the International Agency for Research on Cancer (IARC) have concluded that PCBs are probably carcinogenic to humans. When PCBs are burned, they convert to dioxins, which are highly toxic.

PCBs can still enter the environment through leaks from old transformers containing PCBs. Cleanup of contaminated transformer oil spills is extremely expensive as PCBs are treated as hazardous waste.

Rotek Industries in Germiston have facilities for decontaminating old transformers and capacitors containing PCBs.

7.2.2.1 Recommendations

The extent and location of residual PCB contaminated oil (if any) in CTMM electrical facilities should be assessed, and an action plan drawn up to dispose of the remaining chemicals. The action plan should take into account the proximity of facilities available for decontamination.

7.2.3 Electromagnetic fields

Since 1979, epidemiological studies have raised concerns over the links between exposure to power line frequency magnetic fields and childhood cancer, particularly leukaemia in children. Concern has grown over the potential health effects of long term exposure and/or peak exposure to weak electromagnetic fields (EMF), such as those generated by high voltage transmission lines or electricity distribution lines. These low frequency (50 Hz or 60 Hz) fields are increasingly thought to be carcinogenic and to be a cause of miscarriages.

In North America and Europe, EMF has become an influencing factor in planning and siting new transmission lines.

Both peak exposure and long term exposure have been examined in many studies, although results are not yet considered conclusive. The most recent and definitive are briefly outlined below.

7.2.3.1 International Agency for Research on Cancer (IARC)

An IARC study group reviewed studies related to carcinogenicity of static and extremely low frequency (ELF) electric and magnetic fields in 2001. Using the standard IARC classification that weighs human, animal and laboratory evidence, IARC concluded that ELF magnetic fields were possibly carcinogenic to humans. This classification is the weakest of three categories of carcinogenicity:

- Is carcinogenic to humans (usually based on strong evidence of carcinogenicity in humans)
- Probably carcinogenic to humans (usually based on strong evidence of carcinogenicity in animals)

- Possibly carcinogenic to humans (usually based on evidence in humans which is considered credible, but for which other explanations cannot be ruled out)

For reference, other substances considered possibly carcinogenic include:

- Coffee
- Styrene
- Petroleum engine exhaust
- Welding fumes

7.2.3.2 EPRI/California Department of Health Services/US Dept of Energy

Two large epidemiological studies published in 2002, one carried out by the California Department of Health Services (CDHS) and the other by the Kaiser Foundation Research Institute, found an increased risk of miscarriages among California women who were exposed to high peak magnetic fields in early pregnancy. On the basis of these results, the CDHS concluded that a substantial proportion of miscarriages might be caused by EMF. This conclusion contradicted previous studies, which had shown less definitive results, so a workshop was commissioned to review the data and recommend future research. The joint project found that 24-hour peak exposure measures from different studies were not comparable. A particular conclusion was that a maximum measured on one day in an individual's home may not be representative of the maximum for another day.

7.2.3.3 World Health Organization

A great deal of research has been carried out to assess the related health effects and is documented by the WHO, which recently established the International Electromagnetic Fields (EMF) Project (http://www.who.int/mediacentre/factsheets/fs263/en/) to review research and conduct risk assessments of exposure to static and extremely low frequency (ELF) electric and magnetic fields.

7.2.3.4 CIGRÉ

At the recent CIGRÉ (Conseil International des Grands Réseaux Électriques – International Council on Large Electric Systems) conference held in Paris in September 2004, a session was dedicated to current research and developments on the topic, at which it was noted (Conti and Fanelli) that in Italy, legislation provides for regulation of exposure to EMF.

There appear to be few reports providing recommendations on how electricity utilities and local governments can practically manage remedial and mitigating measures, apparently because evidence is not yet conclusive enough.

7.2.3.5 Recommendations

A basic measure would be to ensure that residents who build houses in the rights of way of power lines are informed that not only is the siting of their house illegal, but it also represents a potential, but not proven, health risk. Despite the abstract and complex nature of the subject and the resulting potential for oversimplification by all parties, a well-bounded awareness program for Tshwane residents based on definitive research should be considered.

CTMM electricity and health staff should ensure they are jointly well-informed on ongoing research on the subject, as part of a long term agenda to assess the health and environmental effects of energy in Tshwane.

7.3 PRESSURES ON AIR QUALITY

In this study, reference to air pollution is made specifically in terms of air pollution generated through processes to produce either electricity or energy in or near Tshwane.

Air pollution can be defined as the emission of chemical compounds into the air resulting from anthropogenic and natural activities, which have the potential to impact negatively on the environment.

Air movement is an effective means of transporting such pollutants. Thus the effects of pollution in one area may also be felt in an area thousands of kilometres away. Air movement and mixing is dependent upon differences in high and low pressures and the occurrence of temperature inversions. Atmospheric constituents are removed from the air through the process of wet or dry deposition or through chemical reactions. Wet deposition is effective in removing both particulate and gaseous pollutants.

Due to the nature of activities that are undertaken within the CTMM, sources of pollution within this area vary considerably and include heavy manufacturing industries, two coal fired power stations, light industrial processes, waste sites, motor vehicles, farming and domestic fuel combustion. The CTMM is surrounded by urban areas to the south (Johannesburg) and rural/farming areas to the north, east and west.

Beyond its immediate borders CTMM is linked to a cluster of metallurgical industries (Witbank and Middelburg), and power generation facilities and coal mines on the Mpumalanga Highveld to the east. From this short description it can be seen that whilst the CTMM does have significant pollution sources within its geographical area, its air quality can be impacted by pollution sources well beyond its boundaries.

7.3.1 Air quality impacts

Air pollution may result in disturbances to ecosystems, climatic conditions, biogeochemical cycles and human health. Motor vehicles are generators of carbon monoxide and carbon dioxide, which contribute to the global greenhouse gas budget which in turn results in global warming. Nitrogen oxides (NOx) emitted by motor vehicles, are precursors to ground level ozone which can trigger serious respiratory problems. Other pollutants from motor vehicles include SO2, a primary contributor to acid rain and volatile organic compounds (VOCs) some of which are known carcinogens. VOCs are also precursors to ground level ozone.

Domestic coal and wood combustion generates both gaseous and particulate pollutants. The more important gaseous pollutants include SO_2 and VOCs, which pose ecological, and health risks to the floral and fauna environment. Particulate matter especially those in the respirable size range (<10µm) poses both a health risk to human receptors and degrades the visibility of an area.

The components of the landfill gas most likely to cause a health risk theoretically constitute 2% of the total volume of landfill gas emission consisting of VOCs that include acetone, benzene, methylbenzene, dichloropropane, tetrachloroethylene, xylene, toluene, ethylbenzene and inorganic gases such as hydrogen sulphide (source of odours), hydrogen cyanide, ammonia and chlorine being the most prominent emissions. In most cases the most severe impacts from landfill gas emissions are limited to areas within 3 km of the waste site and include nuisance (odours and dust), health (exposure to VOCs and other gases) and ecological (degradation of vegetation in close proximity to the waste sites) impacts on receptors.

Given that the majority of air emissions from waste sites are largely composed of methane and carbon dioxide (which are greenhouse gases), waste sites certainly do have an impact on the global greenhouse gas budget. Hence whilst these types of emissions are not necessarily observed by the public (visually and olfactory) they do impact on the global atmosphere.

Domestic coal burning and coal fired boilers are recorded as the most significant fuel burning related sources of airborne particulates in the CTMM region. Coal boiler operations included.

The highest sulphur dioxide concentrations were predicted to be due to emissions from domestic coal burning, petrol-driven vehicles and various coal boiler operations. Ambient benzene and lead emissions are primarily the result of petrol vehicle emissions.

Of these, the most significant source of pollution related to either energy generation or consumption is the contribution from domestic fuel use. Although industrial activities do indeed contribute to air pollution in Tshwane, it is not possible at this stage to disaggregate the data to show to what extent the pollution relates to energy generation or consumption.

By the same token, at this stage it is not possible to disaggregate data to show the extent to which energy production and use contribute to water pollution.

7.4 SOURCES OF EMISSIONS WITHIN CTMM

7.4.1 Greenhouse Gas Emissions

Greenhouse gases include the following:

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

Greenhouse gases emitted through energy generating processes include carbon dioxide, methane and sulphur hexafluoride (found in transformer insulation). Nitrous oxide is typically generated through industrial processes, but is not considered a product of energy generation. Greenhouse gases are measured in tonnes of CO_2 equivalent; one molecule of methane emits 21 times, and (for reference) nitrous oxide emits 311 times, the amount of carbon as their carbon dioxide equivalent.

7.4.2 Fuel Burning Appliances

Information was provided on fuel burning appliances in CTMM from the Air Quality Management Study, as summarized in Table 41 below. It will be helpful to confirm the sizes and numbers of these units, as the information provided gives no basis for evaluating the fuel-burning potential of each installation.

Table 51 Fuel Burning Appliances in CTMM

Fuel Type	Number of Units
Anthracite	34
Anthracite and Coal	5
Oil	31
Coal	138
Diesel	36
Heavy Fuel Oil	4
Wood	11
Boiler	3
Smelter	1
Unknown	18
Total	281

7.4.3 Industry – scheduled processes (including power generation)

Using the 1995 Department of Environmental Affairs and Tourism (DEAT) scheduled processes database, it is estimated that there were *** registered scheduled processes in operation within the CTMM at the time. While this total might be slightly dated, it is the most accurate estimate available. It is possible that while new processes may have been added to the list some of the processes operating at the time may have closed down. An estimate of the 1995 emissions of certain priority pollutants from scheduled processes is given in Table 43.

Table 52 Estimated emissions of priority pollutants emitted by scheduled processes

POLLUTANT	EMISSIONS (TPY)
Total particulate matter	20 417
Sulphur dioxide (SO_2)	48 326
Nitrogen oxides (NO_x)	56 132
CO_2	13 162 414
CO	567 700
Non-methane hydrocarbons	85 040

Source: DEAT (1995)

It is important to note that the figures presented in Table 43 exclude emissions from other sources, such as light industry (non-scheduled processes), motor vehicles, domestic fuel combustion, and mining and waste disposal sites.

The two major types of energy related pollution within this sector are air and marine pollution. The industrial sector is the prime contributor to air pollution. Coal combustion can lead to particulate matter in the air, as well as contribute to acid rain.

In addition to industrial pollution, low-level atmospheric pollution often results from coal combustion in stoves, as well as coal-heated boilers that are found in hospitals and factories (EIA 2002).

7.4.4 Industry – non scheduled processes, light industry

While individual light industries may not be considered to be major sources of air pollution individually, their cumulative contribution to the total air pollution load could be significant. Currently there is no estimate of the contribution of the light industrial sector is to the total air pollution load. Based on the number of industries that operate in this area they could have a significant contribution to the total load. Whilst the air emissions from this sector are not expected to be noxious to their immediate environment when compared to scheduled processes, their cumulative contribution to the greenhouse gas emissions may be significant since many of these operations use fossil fuels such as coal, oils and diesel, which generate greenhouses gases on combustion.

7.4.5 Transport

Emissions from the various transportation modes that are encountered in this area are likely to be a significant air pollution source. Of the various transport modes, road (vehicle) transport is considered to be the most significant regional source of air pollution. Vehicles emit carbon monoxide, carbon dioxide, nitrogen oxides, sulphur dioxides and volatile organic carbons (VOCs). Emissions are evaluated in Section 7.5.

The South African government published a draft strategy in 2003 on the control of exhaust emissions of road-going vehicles[23] . This strategy takes local conditions into account as well as developments in other developed countries. The definition of clean fuels, as applicable from 2006 is

> *"any fuel that does not contain heavy metals and having a maximum benzene content of 3%, aromatics content of 42%, sulphur level of 500ppm and a maximum oxygenate content of ethers and selected alcohols of less that 2.7%. Diesel that contains less that 500 ppm of sulphur will also be included".*

This means that lead in petrol will have to be phased out, the use of lead replacement additives investigated and sulphur in diesel extensively reduced. The refinery sector has estimated that this policy will require investment in existing refineries of between R7 to R10 billion. Government is investigating measures that will support this action, but in the end the cost of fuel will have to be increased to carry the higher costs as the "polluter pays" principle will apply. The draft strategy states that the regulated price build up for petrol and diesel will be based on cleaner fuels only. Any other additional costs incurred in the marketing or distribution of fuels containing heavy metals would be excluded accordingly.

[23] Government Gazette no 25714 vol 462, 12 December 2003, Draft Joint Implementation Strategy for the Control of Exhaust Emissions for Road Going Vehicles in the RSA.

In addition European standards for vehicle emissions limits will be implemented for newly homologated vehicles in 2005. These standards will come into full effect in 2006 when all new vehicles will be subjected to emissions controls.

7.4.6 Households

Domestic households have the potential to be one of the most important sources of air pollution. As is the case with light industry, individual households are low volume emitters of air pollutants but their cumulative impact is significant. Air pollution from domestic households occurs primarily due to the combustion of fossil fuels as an energy source.

The use of coal and wood as a domestic source of energy is the most significant source of air pollution at a metropolitan level. In addition, wood and coal combustion is the primary energy source in low income population groups as well as the numerous informal settlements that are dispersed across the CTMM. This is significant during winter when strong inversion conditions prevail over the Highveld resulting in poor dispersion conditions i.e. the accumulation of air pollution levels in the first 100 to 300 m above ground level. Studies in the Vaal Triangle have shown that the contribution of domestic coal combustion can contribute 40 to 60% of the atmospheric pollution load during winter (EMM State of the Environment 2004).

Including electricity consumption, coal (mostly bituminous), is the primary fuel consumed in CTMM. Production and consumption of coal has serious effects on the environment, leading to air and water pollution, whist also contributing to increasing concentrations of greenhouse gases in the atmosphere.

7.4.7 Mining

7.4.8 Waste sites

With respect to air quality, waste sites are a source of gaseous and particulate emissions. Methane and carbon dioxide theoretically constitute 45% to 55% of landfill gas. Particulate matter is usually wind derived and associated with operational activities including waste disposal, vehicular movement, and waste compacting and covering. It is understood that CTMM is currently considering using currently flared landfill gas for other purposes, and this may have a beneficial impact on the air pollution related to waste sites.

7.5 GREENHOUSE GAS EMISSIONS EVALUATION

Greenhouse gas emissions have been evaluated from two sources:

- Vehicular transportation data
- Non-transportation data, summarised in the energy balance presented in Section 4.

7.5.1 Vehicular Transportation Modelling

Information on energy emission within CTMM was extracted from a planning tool used by the city for strategic transportation planning purposes, the CTMM's EMME/2 regional transportation model. The software model simulates the distribution of traffic demand on the existing and future road network within the City. Real-life factors such as average speed, gradient, roadway capacity and volume-delay functions to simulate congestion are incorporated into the modelling process to accurately create a picture of existing and future traffic movements.

The EMME/2 model was converted to VISUM, which is part of the German-developed software suite PTV_Vision. This suite is aimed at traffic and transportation modelling, but also allows emissions modelling to be performed based on vehicle movements (distance travelled, speed and gradient).

Two approaches for the determination of emissions were followed. In the first approach, the total annual vehicle-kilometres, calculated using the transportation model as described in section 5.1.7, was multiplied with coefficients determined in South African studies to determine the carbon dioxide and methane emissions.

In the second approach, the German modelling software Ptv VISUM was used to calculate the noxious gasses emitted by vehicles on the network. However, it must be noted that the software relates emissions to European norms, and only provide an order of magnitude idea as to the emissions in Tshwane.

7.5.1.1 Carbon Dioxide and Methane Emissions

The emissions coefficients for carbon dioxide and methane were determined by Wong (1999) and Stone (2000). These factors were used multiplied by the total annual vehicle-kilometres and diesel/petrol split calculated in section 5.1.7, with the split of vehicles between petrol with and without catalytic converters, established as 7,3:92,7 and the split between leaded and unleaded calculated from fuel sales as 58:42. The following total annual emissions were calculated and are shown in **Table 53.**

Table 53: Transportation and Energy CO_2 and CH_4 Emission Information from EMME/2 Model

Pollutant	Total Annual Emissions (tpa)		
	Diesel-driven Vehicles	Petrol-driven Vehicles	Total
Carbon dioxide	1177235.1	1341343.9	2518579.0
Methane	308.1	266.8	574.9

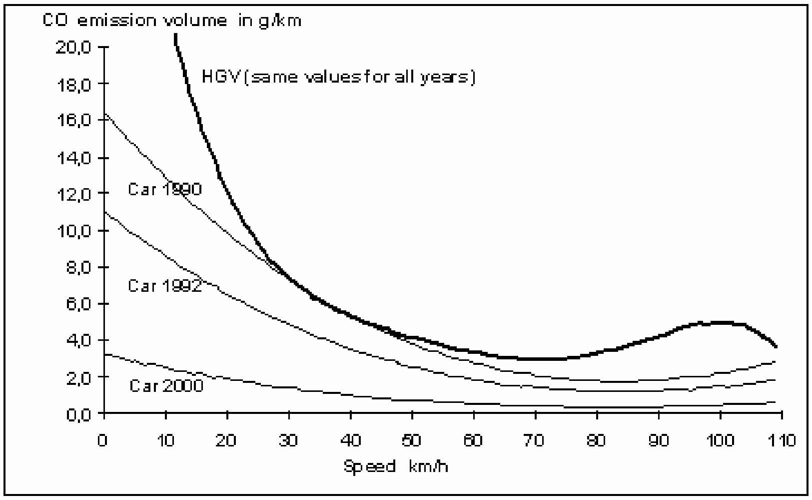
7.5.1.2 Other Noxious Gases

In VISUM, three models for calculating environmental impact are available:

- Noise-Emis-Rls90: calculation of noise emission levels in accordance with RLS-90 (guideline on noise reduction for roads by the Federal Minister for Traffic in Germany).
- Noise-Emis-Nordic: calculation of noise emission levels in accordance with the Nordic Council of Ministers (1996): Road Traffic Noise. Nordic Prediction Method. Tema Nord 1996:525 (ISBN-No: 9291208361).
- Pollution-Emis: calculation of pollution emission level in accordance with emission factors of the Federal Office for the Environment of Switzerland (BUS).

The polynome approximation of emissions relative to speed show the following developments for CO for different reference years:

Figure 51 **Relationship between vehicle speed and emissions**



Recent measurements have shown that actual emission values are generally overestimated by 1990 calculation factors, because the change in vehicle fleets (more vehicles have now been equipped with catalytic converters) has contributed to decreasing volumes per vehicle.

The latest Swiss emission factors take this change into account with modifications for the years 1992 and 2000.

The VISUM model was used to quantify the amount of pollutants emitted by vehicles in CTMM. The following information was extracted:

Table 54 Transportation and Energy Emission Information from EMME/2 Model

Item	Amount	Unit
Total vehicle kilometers during the morning (AM) peak hour:	**2,578,594**	veh-km
Total road network in model (in lane-kilometers):	**8,477**	km
Total volume of traffic on network in peak hour:	**251,171**	vehicle trips
Total vehicle-hours travelled in peak hour:	**42,814**	veh-hours
Annual Emissions		
EDAT_NOX	19527.25	[tpa]
EDAT_SO2	333.73	[tpa]
EDAT_CO	28399.09	[tpa]
EDAT_HC	4265.84	[tpa]
NOISE	1717984.19	dB

From **Table 54**, the following conclusion can be made (for the AM peak hour):

- A total of 251,171 vehicle trips results in 2.6 million vehicle-kilometres being travelled during the morning peak hour in CTMM on a total of 8 500 lane-kilometres. These vehicles spend more than 42,800 vehicle-hours during the peak hour period.
- These 251,171 vehicles trips emit an estimated 6,372 kilograms of nitric oxides, 109 kilograms of sulphur dioxide, 9,267 kilograms of carbon monoxide and more than 1,390 kilograms of hydrocarbons.

The abovementioned emits (refer to Table 54) are presented graphically in to Figure 55 below.

The following conclusions can be made:

- High concentration of emissions are found on the R28 / N1 to Johannesburg and the R21 towards the Ekurhuleni Municipality.
    - These can be attributed to the large volumes of vehicle, particularly during the congested peak periods, travelling along these routes.
- Major arterials in CTMM (R80 - John Vorster Road from the northwest of CBD, Church Street from the west, R55 – Voortrekker Road located southwest of the CBD, R513 – H F Verwoord Drive to the north of the CBD, R101 – Paul Kruger Street to the north of the CBD) experience low emits when compared to the R28 / N1 and the R21.
- The N1 from the section north of Zambezi Road has substantially lower emissions, compared to the sections of the N1 to the south of Zambesi Road.
    - This indicates the discrepancies between the north and the south of Tshwane in terms of vehicular traffic, which provides a hint as to the differences in the lack economic development to the north.
- The region within the CTMM enclosed by the N4, the R28 and the N1 has the highest concentration of emissions.
- The above-mentioned region has unpolluted pockets, e.g. areas around the Waterkloof Airforce Base and the Groenkloof Nature Reserve.

Figure 52 Nitric Oxide Emissions in CTMM

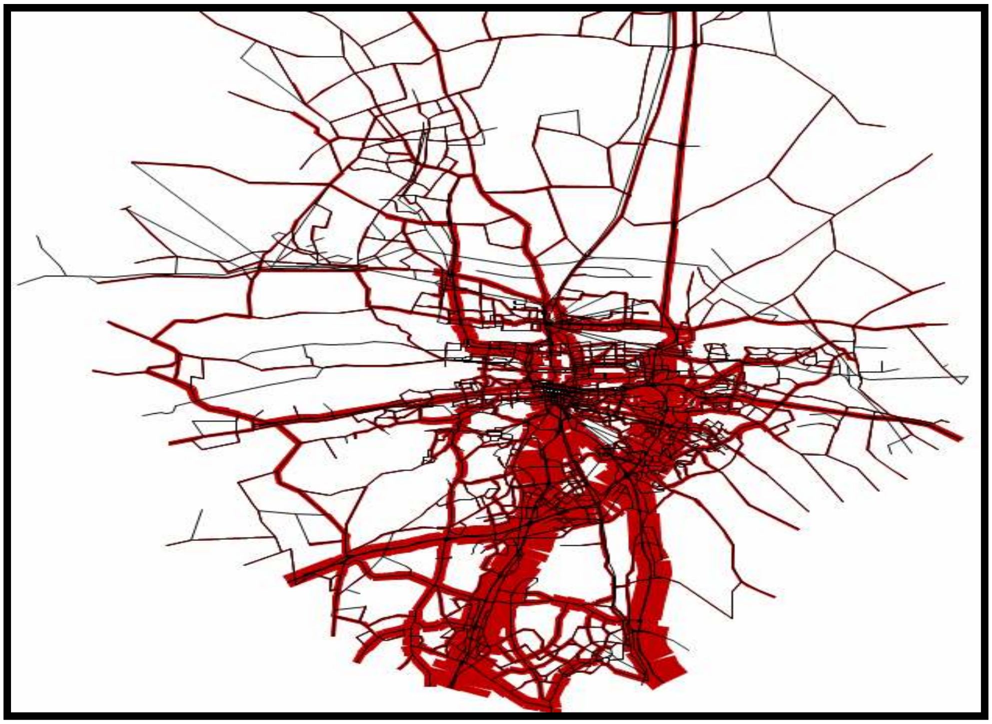


Figure 53 Sulphur Dioxide Emissions in CTMM

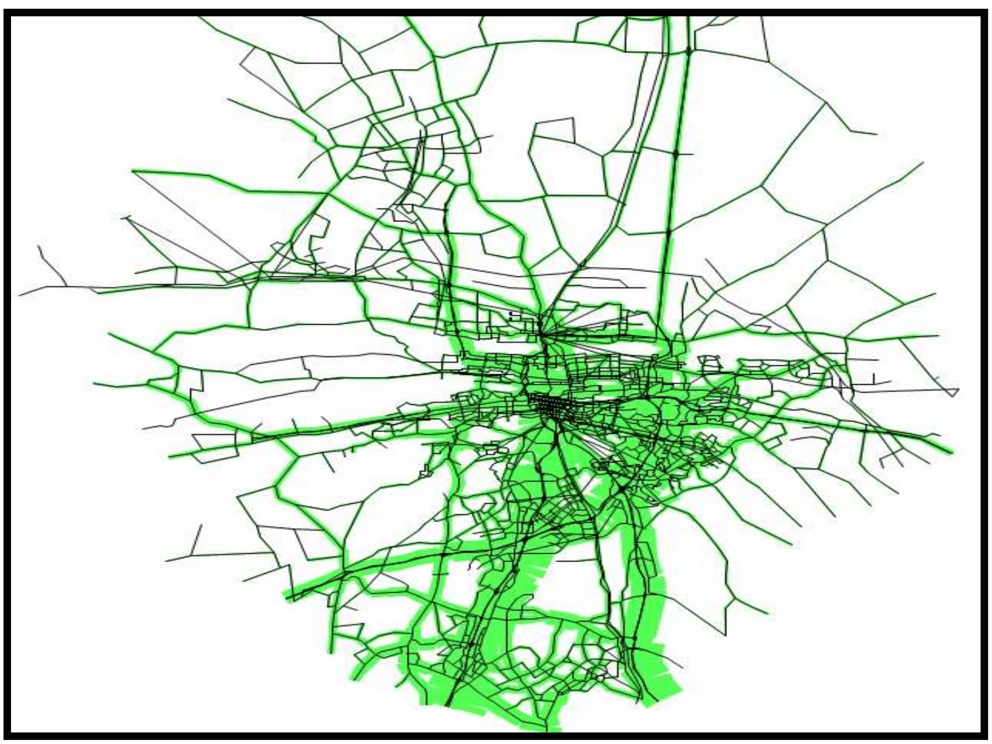


Figure 54 Carbon Monoxide Emissions in CTMM

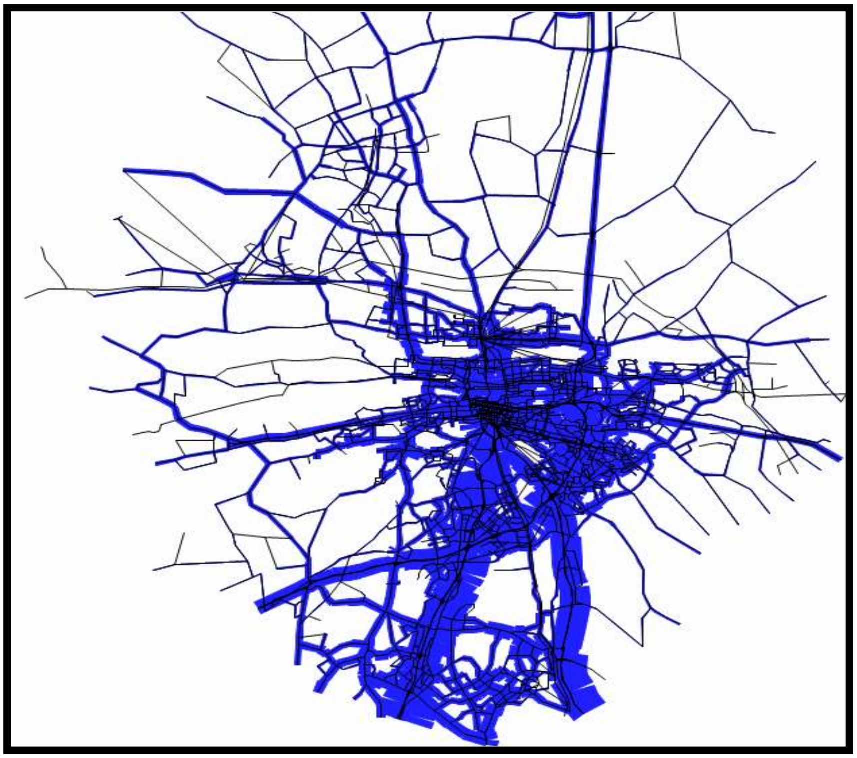


Figure 55 Hydrocarbon Emissions in CTMM

7.5.1.3 GHG emissions from energy sources

The project team has estimated Tshwane's current greenhouse gas emissions using a method based on South African research, as presented by Blignault et al (2005). As agreed with the client, the estimates are limited at this point to the two major greenhouse gases, carbon dioxide (CO_2) and methane (CH_4).

Blignault's methodology is based on a refinement of the methods developed by the Intergovernmental Panel on Climate Change (IPCC), the chief scientific body for this activity worldwide. Blignault has devised a set of *emission factors* for different energy sources, which take account of South Africa's unique energy mix. The method enables a projection of GHG emissions based on an energy balance for the country as a whole or a specific region or municipality.

Because this is a "static" method and uses fairly generalized emission factors, the results may differ from more dynamic and specific methods. The consultant intends to continue to review these methods and reserves the right to provide an alternative analysis as part of the continuing development of the Tshwane Energy Strategy.

The results of the initial assessment are provided on the following page, in the form of a table based on the energy balance table in Section 4.3. This shows that direct GHG emissions from energy sources in Tshwane account for approximately 7.22 million tonnes of CO_2 equivalent per year, against a national total (calculated by Blignault for 1998) of some 352 million tonnes.

Table 55 Summary of GHG Emissions (Carbon Dioxide and Methane) from Energy in Tshwane Municipality

Terajoules converted to Tonnes of CO_2 and CH_4

Fuel Type	Transport Liquid Fuels	Transport Liquid Fuels	Transport Liquid Fuels	Stationary type liquid fuels	Stationary type liquid fuels	Stationary type Liquid fuels	Sasol gas	Sasol gas	Sasol Gas	Electricity
Units	Tj	tCO_2	$kgCH_4$	Tj	tCO_2	$kgCH_4$	Tj	tCO_2	$kgCH_4$	Tj
Primary Imports										0
Secondary Imports	39,915	2,815,621	399,153	4,994	356,143	4,994	1,812	101,674	1,812	0
less aviation bunkers										
less losses										3,669
Secondary supply	39,915	2,815,621	399,153	4,994	356,143	4,994	1,812	101,674		-3,669
Households	0	0	0	1,154	82,314	1,154	0	0	0	11,300
Industry/construction	591	41,714	5,914	45	3,219	45	1,812	101,674	1,812	12,112
Mining and quarrying	198	13,939	1,976	16	1,108	16	0	0	0	0
Commerce	2,484	175,188	24,835	2,605	185,750	2,605	0	0	0	4,262
Local Government	642	45,319	6,425	0	28	0	0	0	0	0
Agriculture	244	17,222	2,441	20	1,401	20	0	0	0	513
Transport	35,756	2,522,239	357,562	1,154	82,323	1,154	0	0	0	0
Total final consumption	39,915	2,815,621	399,153	4,994	356,143	4,994	1,812	101,674	1,812	28,187
Conversion factors	34.2	70.54	10	39.85	71.31	1	1	56.10051	1	3.6
	MJ/l	tCO_2/TJ	CH_4/TJ	MJ/l	tCO_2/TJ	CH_4/TJ		tCO_2/TJ	CH_4/TJ	MJ/kWh

NOTE: This table uses conversion figures from Blignault et al (2004), for converting energy in Terajoules to tonnes of CO_2 and CH_4

Blignault includes adjustments for converting C to CO_2 and for oxidation in the basic emission factors.

7.5.1.4 Non-energy methane emissions

The Blignault method provides estimates of energy-based emissions only. Emissions of methane from agricultural or landfill sources must be calculated using a different methodology, linked to the characteristics of the source itself. As this study either did not include collection of this kind of data (in the case of agriculture) or was unable to determine the necessary information (in the case of landfills), the development of an accurate estimate of methane emissions from non-energy sources has not been possible.

The consultants have however located a number of tools for estimating GHG emissions from landfills and will be reviewing these with municipal staff in the hope that Tshwane can adopt them and develop emission estimates on their own. Using these tools requires information on, for example, the annual rate of deposition, the current volume and effective containment of the landfill, the typical humidity conditions including any introduced liquids, and the presence of inorganic as well as organic materials.

It is suggested that Tshwane make an effort to develop this information and experiment with the *Landgem* tool from the US Environmental Protection Agency in order to generate order-of-magnitude estimates of landfill gas emissions. If the volumes appear to be significant, a pilot testing of emissions may be warranted.

The locations of the 9 major Tshwane landfills and their general composition and areas are provided on the following page in the form of a table and graph.

Figure 56 Landfill Sites and Sources of Waste, Tshwane Municipality

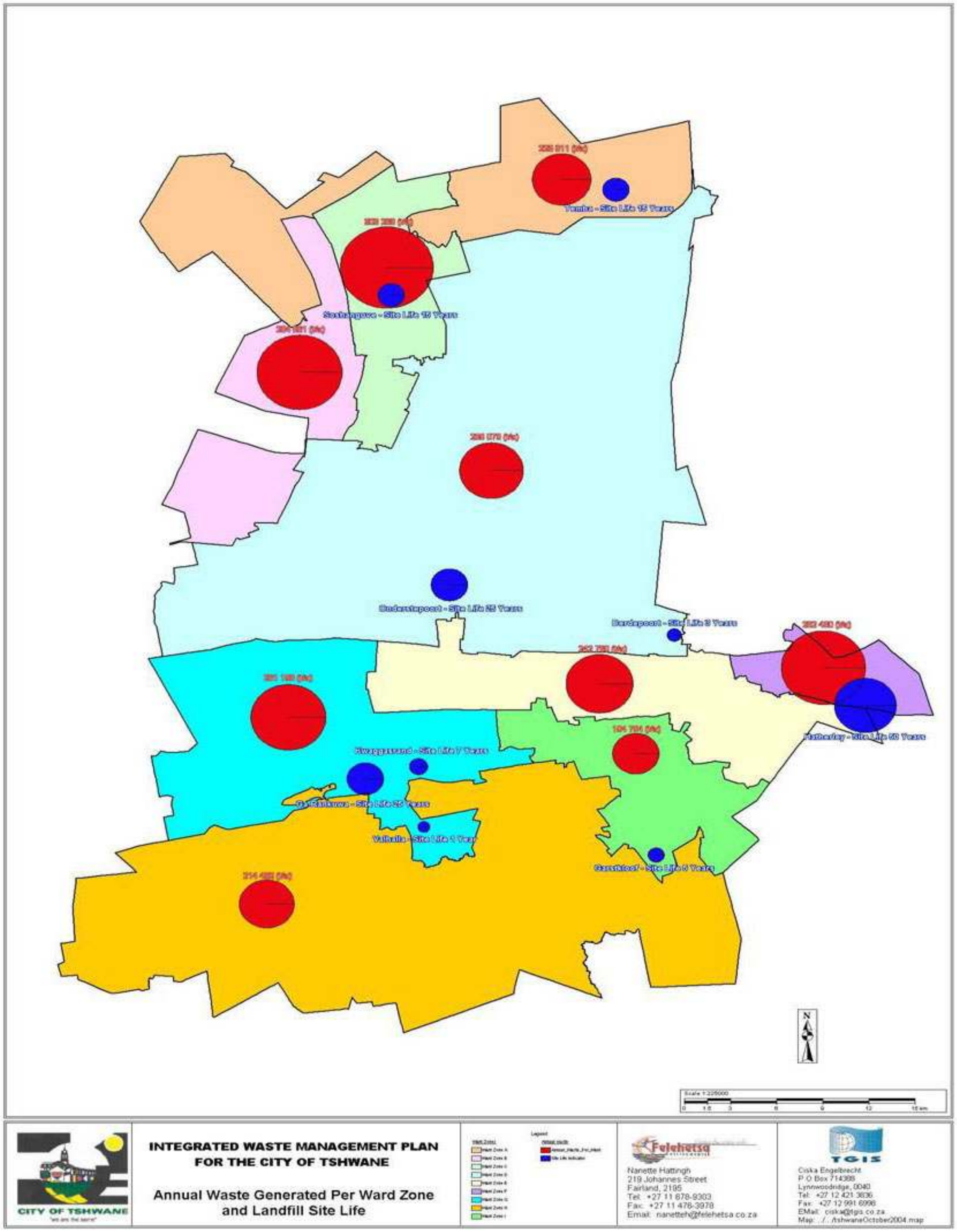


Table 56 Status of Landfill sites in Tshwane

Landfill Site	Status	Landfill Area (Ha)
Derderpoort	Site to be closed in 3 years	12,40
Hatherley	Airspace estimated to be 50 years	+/- 96,00
Ga-Rankuwa	Site to be operational for 20 – 25 years	41,90
Garstkloof	Site to be closed within next 5 years	43,60
Kwaggasrand	Site to be operational for 5 – 7 years	27,20
Onderstepoort	Site to be operational for 20 – 25 years	51,82
Soshanguve	Site to be operational for 10 – 15 years	39,17
Temba	Site to be closed in 6 – 12 months	+/- 3,70
Valhalla	Site to be closed in approx. 2 months	11,70
Eerserust	Closed 1993	
Mamelodi	Closed 1997	
Pretoria North	Closed 1993	

7.6 HUMAN HEALTH

The detrimental effects of air pollution on human health are well documented. These are, in summary:

- Acute/short term: bronchitis, tightness in the chest, wheezing.
- Chronic: lung cancer, cardiopulmonary disease.

Mortality rates are higher in cities with dirtier air; it is estimated that exposure to particulate levels exceeding the World Health Organization health standards accounts for roughly 2 to 5 percent of all deaths in urban areas in the developing world[24] . More critically for CTMM, it has been shown in South Africa that mortality is dramatically increased in those families which chronically breathe coal and woodsmoke emissions in poorly ventilated dwellings, which is typically the case for poor residents during highveld winters. It is estimated that around 2000 children die annually as a result of respiratory infections caused by air pollution, the sixth largest killer of children under four in South Africa[25] .

Vulnerable groups include infants, the elderly, and those suffering from chronic respiratory conditions including asthma, bronchitis or emphysema. However, even healthy adults can also suffer negative effects.

[24] World Resources Institute, 1999.

[25] EIA 2002

7.7 INFORMATION AND DATA GAPS

There are a significant number of gaps with respect to air quality data in the CTMM and this includes both emissions (source) and ambient data. With respect to source data there is a need for the establishment of a comprehensive emissions inventory from all potential sources of air emissions within the CTMM for certain priority pollutants. This will be a licensing requirement for "Listed Activities" (currently termed Scheduled Processes), which will be a local government responsibility when the Air Quality Bill is promulgated. In terms of this study, the net effect is that the information related to pollution caused by energy production and/or use in CTMM is simply not available at this stage. However, some reasonable inferences can be drawn.

7.7.1 International trends in data requirements

South Africa has ratified and acceded to the Kyoto Protocol in 2002. Although South Africa is not obliged to reduce greenhouse gas emissions during the initial period required under the Protocol (2008 to 2012), this could change after 2012 especially when the protocol is implemented. Important commitments include quantification and reduction of greenhouse gas emissions that are emitted within South Africa.

The collation of this information will almost certainly require local government input either in the form of promulgation of legislation or collation of information that has been supplied by generators of air pollution that fall within its jurisdiction. With respect to ambient air quality data, a comprehensive ambient air quality monitoring plan is in preparation, following on the preparation of the air quality baseline study.

7.8 ISSUES RELATING TO ENERGY AND CTMM'S ENVIRONMENT

The development of an ambient air quality monitoring program will assist the CTMM in prioritising air monitoring programmes with a view of addressing the air pollution hotspot areas first and progressively expanding the network to other areas. All emissions and ambient air quality information must be forwarded to and collated at a centralised point in a GIS based system that will allow for easy access to information by the various stakeholders in the CTMM including local government, the public and business sectors.

By far the most significant energy-related factors affecting air quality in CTMM are vehicular transport as well as domestic and industrial consumption of coal (direct and indirect through electricity consumption).

8. STATE OF ENERGY

8.1 IDENTIFICATION AND PRIORITISATION OF ENERGY ISSUES IN CTMM

In light of the facts presented in the preceding chapters, a process for confirming key energy issues with stakeholders will be agreed with CTMM.

A long list of issues has been identified in this section, for the purposes of discussion and confirmation with CTMM stakeholders.

Taking into account CTMM's service delivery objectives, the following section deals with highlighted energy issues in CTMM with respect to a common Service Delivery Framework of Strategy & Policy, Planning & Design and Operation & Maintenance.

Table 57 Identification and prioritisation of energy issues in CTMM

ISSUE	COMMENT	PRIORITY
Strategy & Policy		
Transportation		
Transportation demand sector is the major energy user and major pollutant	Large component of energy is used for transport – not much is known about the use of energy in the transport sector – energy needs to be a specific variable that is address in all the transport planning activities, especially related to personal transport.	High
Awareness building is needed for the public to understand the consequences of energy intensive transport	Mindset shift will likely be an issue ("all South Africans want cars and want to drive alone"), with a need for different programs addressing different income groups.	High
Limited availability of public transport (alternatives to taxis)		Medium
Congestion should be addressed through the construction of limited new infrastructure and Travel Demand Measures such as carpooling should be encouraged	Perhaps through use of designated lanes, with monitoring and enforcement through CCTV systems at key points.	High
Integration with spatial development planners to reduce required trips and trip-lengths		High
Implications of the new national policy on exhaust emissions should be assessed from CTMM's perspective.	SA government is to supply clean petrol and diesel by 2006. Implications for fleet upgrade/ replacement should be addressed.	High
Need for roadworthiness tests of current vehicles in CTMM (trucks, taxis and private cars) to assess emissions and fuel efficiency	Need to be monitored in terms of infrastructure and policy implementation once national policy has established. Municipal bylaws can assist in enforcing roadworthiness requirements.	High

ISSUE	COMMENT	PRIORITY
Need for alternative, environmentally friendly modes of travel to be available and safe (bicycle, pedestrian options) for CTMM residents		High
Need for alternative, environmentally friendly fuel (methane, ethanol, hydrogen, fuel cells, diesel from sunflower oil, etc.) and vehicle technology (hybrid/electric vehicles), to be more readily available to CTMM residents		High
Implications of new policy on exhaust emissions on CTMM will have to be examined		High
Electricity		
Rollout of the incorporation of municipal electricity undertakings into Regional Electricity Distributors (REDs), which will incorporate Eskom distribution. Objective is to introduce efficiency into the electricity supply chain and national tariffs.	Implications for CTMM RED include: o Contestable customers (large power users will have the opportunity to select suppliers) o Responsibility for planning for future capacity and need for integration in planning between generation, transmission and distribution o Planning for O&M of infrastructure o Potential for increase in electricity price (carried through from generation) – end user affordability	High
Need for a centralised and accurate electricity database, consolidating technical, financial and geospatial information	Could also be used for tariff analysis, DSM planning, policy development, planning and marketing	High
Need to maintain/improve quality of electricity supply	Contributing factors include lack of funds for preventive maintenance, vandalism, illegal connections, and potential lack of supply capacity nationally after 2007. Impacts on industrial, commercial and residential consumers. If perception of lack of reliable electricity supply persists, investment (especially industrial development) could start to follow perceived reliable electricity supply.	High
Sufficient funds should be made available for repair and maintenance of the distribution system.	Some substation repairs have taken months to effect as funds were not allocated, affecting supply to customers.	High

ISSUE	COMMENT	PRIORITY
Sufficient capex and opex need to be made available for the development of new infrastructure.	This will take on even greater importance with the rollout of the REDs.	High
Electrification policy should be tied to socio-economic development of the region.	CTMM should ensure close liaison with DME on planning of future electrification rollouts.	High
Environmental and health issues		
Coal is used extensively in low income households. Emissions from coal at the household level are extremely high	Impacts are on householder health as well as the environment. CTMM could implement mechanisms to support the DME's initiative to introduce LPG into lower income homes. Incentives could be considered to make LPG more accessible, as well as awareness programs concerning the health effects of coal and IP.	High
Illuminating paraffin is a potential source of fire in low income homes		
Emissions from coal-generated electricity affect the atmosphere in South Africa	CTMM generates electricity within its borders	High
PCBs may be present in old electrical equipment such as transformers and capacitors (and fluorescent light ballasts). PCBs are carcinogenic, and become more dangerous when burned.	The extent and location of residual PCB contaminated oil (if any) in CTMM electrical facilities should be assessed, and an action plan drawn up to dispose of the remaining chemicals. The action plan should take into account the proximity of facilities available for decontamination.	Medium
Electromagnetic radiation from overhead high voltage power lines is believed to be a potential carcinogen and cause of miscarriages, although studies are not conclusive	A basic measure would be to ensure that residents who build houses in the rights of way of power lines are informed that not only is the siting of their house illegal, but it also represents a potential, but not proven, health risk. Despite the abstract and complex nature of the subject and the resulting potential for oversimplification by all parties, a well-bounded awareness program for Tshwane residents based on definitive research should be considered. CTMM electricity and health staff should ensure they are jointly well-informed on ongoing research on the subject, as part of a long term agenda to assess the health and environmental effects of energy in Tshwane.	Medium
RE/EE/DSM initiatives		
Low level of penetration of RE/EE strategies within CTMM	At national level, draft strategy was issued in April 2004. NER policy states that munics, as REDs, to deliver on EEDSM targets.	High
Waste to energy projects should be encouraged	Such projects may have potential CDM benefits as well as contributing to CTMM's	High

ISSUE	COMMENT	PRIORITY
The potential for cogeneration projects should be explored New housing projects should be required to meet energy efficiency standards.	environmental sustainability. Housing projects should address issues such as passive solar heating and cooling (window and shade placement for keeping houses cool in summer and warm in winter), insulation, ventilation systems, double-glazing of windows, and weather-stripping of windows and doors to keep the indoor environment to the desired conditions. Electricity-intensive air conditioning should be discouraged.	
DME will require appliances to be labelled in terms of their energy efficiency.	CTMM could support in terms of awareness building.	Low
General		
Energy poverty needs to be addressed	Mechanisms for measuring energy poverty should be developed, and targets set for energy poverty reduction	High
Energy costs will likely become cost-reflective, taking into account externalities such as pollution		High
Development of EEDSM related bylaws will be needed	Building permits and zoning regulations may be an appropriate mechanism for incentivising EEDSM in the longer term	Medium
Planning & Design		
Transportation		
Synchronized/phased traffic lights could relieve bottlenecks at peak hours with a resultant decrease in fuel consumption	Vehicles which maintain a regular speed rather than a stop/start pattern use less fuel per kilometre driven.	High
Intelligent Transport Systems should be considered for the longer term.		Medium
Spatial planning should take into account revising the urban form to support energy conscious initiatives such as bicycle paths	For safety and environmental reasons	High

ISSUE	COMMENT	PRIORITY
Better lighting of road networks – brighter, lower consumption streetlights and programmed traffic lights would have cross-cutting benefits	Streetlighting does not represent a significant energy demand sector in CTMM. However, an EE program in streetlighting would be highly visible and would contribute to awareness building on EE, as well as potentially reducing crime and accidents.	Low
Electricity		
Lack of uniform, up to date computerisation of electricity system information	CTMM Electricity is currently planning to roll out an extensive GIS mapping project, which will include provision of computer facilities for municipalities still lacking them	High
Discrepancies in electricity information – description of system, number of customers, losses	Information on number of customers at household level particularly suspect	High
Availability of detailed household energy use information	CTMM should consider a household energy profiling study to establish a database on energy use for cooking, heating and lighting, which could be used for EEDSM. This would typically involve identification of a representative set of households	High
The extent to which the new tariffs are cost reflective should be assessed.		High
Assistance should be provided to consumers in the most effective use of this tariff system.	An active energy use advisory system should be considered.	High
Effective management systems for metering systems (credit and prepaid) should be used to check for illegal connections.		
Awareness programs on the consequences of electricity theft should continue.		
Collaboration with the South African police on enforcing Section 27 of the Electricity Act (regarding theft of electricity) should continue.	Benoni staff reported a significant reduction in illegal connections while their collaboration with SAPS was active.	High
RE/EE/DSM initiatives		

ISSUE	COMMENT	PRIORITY
DME planning to implement energy efficiency monitoring country-wide, and currently seeking to develop the institutional framework and data collection protocols.	CTMM will need capacity to supply the data – resources and specialisation will be essential. DME is implementing several projects under the Capacity Building in Energy Efficiency and Renewable Energy project (CaBEERE), involving industrial energy management, implementation of norms and standards in energy efficiency and monitoring of targets in energy efficiency.	High
Local manufacturers and industries should be made aware of industrial energy management initiatives and availability of training programs		
CTMM should consider developing incentive programs for higher consumption energy users to implement EEDSM, e.g. through installation of solar water heaters.		
CTMM could incentivise through financing and investment	National government is setting up and rolling out incentive programs	Low
General		
Need for energy capacity building in CTMM staff	CTMM are addressing through the SEED project	High
Need for energy capacity building within CTMM's private sector	Ensure that budgets align with priorities; energy is not necessarily considered a priority within industry and commerce. It is considered a very high priority in the mining sector, as electricity typically represents about 20% of production costs.	High
CTMM business were originally established around mines and railways (east-west axis) and were labour intensive; now increasing trend towards high tech businesses, with mode of transport changing to road rather than rail, and moving north.	Land use and transportation planning implications, which will involve energy supply as well.	Low
o Limited data on household use of coal, IP, LPG and electricity - this may call for a longitudinal survey and study.	o This links to the issues of affordability, local health and air quality. o Also the thermal design of new houses related to comfort and energy use o Upgrading of existing houses Advice and assistance to users to use the right form of energy and appliance so as to reduce cost, energy use and pollution- there may be a case for an effective policy of advisory centres	High

ISSUE	COMMENT	PRIORITY
○ Need for alignment of development planning between government levels, and for CTMM IDP to have an explicit energy component.	○	High
Operation & Maintenance		
Environment		
Land based environmental impacts of energy externalities need to be assessed.	Environment and Energy must work together. Other countries, particularly the Scandinavians, have already done extensive work in this area. There may be positive impacts as well, such as the potential use/sale of methane related carbon emissions from landfills. Monitoring and verification will be essential.	Medium
Electricity		
Rigorous efforts to prevent illegal connection through awareness programs and system audits should continue.	Copper cable theft is an economic crime as well as basic theft. Illegal connections are often effected by children, as their small hands can reach into small junction box spaces, exposing them to severe risk of injury and death.	

8.2 SERVICE DELIVERY FRAMEWORK

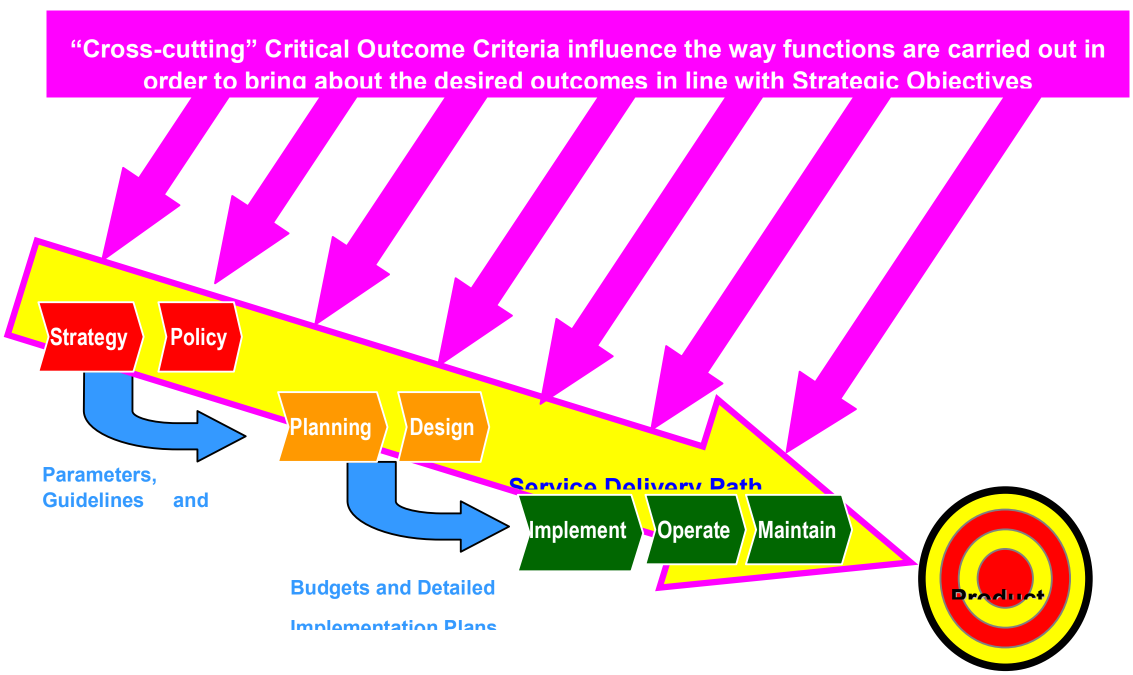
The generic Management Delivery Lifecycle depicted in Figure 35 below is common to all businesses in the delivery of their Products or Services. This encapsulates the three key management functional perspectives of

- Strategic Planning (Strategy and Policy)
- Tactical Planning & Coordination (Planning and Design)
- Operational Delivery & Maintenance (Implementation, Operation and Maintenance).

This Service Delivery Framework can be used to:

- establish desired outcomes
- identify targets
- assign responsibilities and establish interface management protocols between the three key functional perspectives
- provide a coathanger for a monitoring and evaluation mechanism, wherein key performance indicators are established, and feedback mechanisms are in place.

Figure 57 Service Delivery Framework



The desired outcomes, or strategic objectives, realised as a result of the delivery of the product (or service) influence the way in which the various functions on the Service Delivery Path are carried out. Monitoring and verification provides feedback along the Service Delivery Path.

8.3 CONCLUSIONS AND RECOMMENDATIONS

8.3.1 Conclusions

8.3.1.1 Energy Balance – Demand and Supply

In this study, an energy balance was done to assess the fundamental movement of energy via its main carriers through CTMM. This addressed both demand and supply of energy by demand sector and energy carrier. The total demand for energy in CTMM in 2004 was 101.3 PJ.

The transport sector accounts for the largest use of energy in CTMM (36.4%), followed by industry (34.1%) and then households (18.7%). The three remaining sectors, including local government, are low in energy use in comparison, each accounting for only 0.2% to 9.2% of the total.

Linked to this distribution of sectoral energy use, liquid fuels supply most (44.3%) of the energy consumed in CTMM, followed by electricity with 27.8% and coal with 26.1%.

Households display a complex multiple fuel use pattern in serving their energy needs. Electricity is the most used energy carrier in households in Tshwane. Lighting and TV/radio are the two main applications for electricity even when more traditional fuels are used for cooking and heating. Electricity, illuminating paraffin (IP) and coal dominate heating and cooking in CTMM.

8.3.1.2 Supply by Energy Carrier

8.3.1.2.1 Liquid Fuels (44.3%)

The most important marketing channel for liquid fuels is through service stations (71% of total sales), followed by “other resellers” and “other commercial”, each at 11%.

Recently, campaigns have been mounted to improve the safe use of paraffin by the Paraffin Safety Association. The DME is promoting LPG and other low-smoke fuels (coal) in order to minimise the use of paraffin mainly for safety reasons. There are plans to accelerate the use of LPG in the residential sector, particularly in low income households in order to reduce the use of dangerous IP. The South African government plans to supply clean petrol and diesel from 2006. The national government regulates the retail price of petrol, diesel and IP, calculating them through an import parity pricing formula called the Basic Fuel Price. VAT is not applied to paraffin sales, although the impact of this effective subsidy to the intended beneficiaries is under question. Retail pricing for LPG remains unregulated, and the question of whether zero-rating LPG for VAT would benefit poor consumers is being considered.

8.3.1.2.2 Electricity (27.8%)

CTMM has historically purchased about 90% of its electricity from Eskom, with the balance being supplied by Rooiwal and Pretoria West power stations located within CTMM. Total CTMM purchases from Eskom and these stations in 2004 amounted to 8 560 GWh, or 30.8 PJ. Losses (technical and non-technical), estimated from actual loss records provided by CTMM and an estimate of 5% on supply by Eskom Northern Region, total 1.3%. It is believed that this figure is low, and will be further investigated with CTMM staff.

8.3.1.2.3 Coal (26.1%)

Coal is consumed for power generation, industrial and household purposes within Tshwane. There are no collieries in Tshwane. Approximately 1,088,978 tonnes of coal are supplied in Tshwane annually. Coal addresses 57.9% of industrial demand (mainly to fuel steam boilers for industrial processes and laundry) and 34.2% of household demand.

8.3.1.2.4 Piped Gas (1.8%)

Sasol supplies 1.8 PJ via piped gas delivered at three depots, Babelegi, Rosslyn and Pretoria West. This is taken up exclusively by industrial consumers. The consumption of gas is expected to rise, with a commensurate drop in coal consumption as energy users engage in fuel switching.

8.3.1.2.5 Renewables, Energy Efficiency and Demand Side Management (negligible)

The rollout of renewables, energy efficiency and demand side management is still nascent in Tshwane. As the national energy efficiency and renewable energy strategies are rolled out, it is anticipated that Tshwane will incorporate the targets into their IDP and develop associated programmes. DSM activities are expected to increase as the number of Energy Service Companies (ESCOs) increases.

8.3.2 Role of the Municipality with respect to Energy Efficiency and Demand Side Management

Local electricity departments will have to become directly involved in the efficient use of electricity in future. This will result from the energy efficiency strategy of government and the draft policy of the NER on regulating energy efficiency and DSM activities. The policies will most probably lead to local policies and programmes linked to national programmes. It will require that energy efficiency and DSM plans be developed and approved by the NER in order to share in national funding for this purpose.

8.3.3 Restructuring of the Electricity Sector

In 1996 government decided to restructure the electricity distribution sector into six Regional Electricity Distributors (REDs) from Eskom Distribution and the current 189 municipal undertakings involved in electricity distribution, in order to introduce and to achieve a higher level of business efficiency within these larger and more specialised bodies.

This in essence means the merger of Eskom and local government distribution in specific areas and the establishment of national tariffs regulated by the NER rather than a host of tariffs charged by Eskom and the municipalities. It is also expected to mean improved efficiency in electricity service delivery, and CTMM is well advanced in preparations for rolling out the REDs, and is currently evaluating its detailed rollout strategy.

8.3.4 Illegal Connections

Tshwane is subject to illegal connections (theft of electricity), which generally occur when a customer has been cut off for non-payment. Illegal connections have an impact on electricity costs, quality and availability of supply and safety.

8.3.5 Environmental Impacts of Energy Use in CTMM

A qualitative assessment of the environmental impacts of energy use in CTMM was done. By far the most significant energy-related factors affecting air quality and climate change in CTMM are household and industrial consumption of fossil fuels and vehicle traffic.

Coal boiler operations also contribute to airborne particulates. The highest sulphur dioxide concentrations are from emissions from domestic coal burning, petrol-driven vehicles and various coal boiler operations. Ambient benzene and lead emissions are primarily the result of petrol vehicle emissions.

Fossil fuel combustion produces carbon dioxide, sulphur dioxide and nitrogen oxides. There is concern that increasing concentrations of greenhouse gases (including carbon dioxide, methane and manmade chlorofluorocarbons) may enhance the greenhouse effect and cause global warming. Other emissions such as sulphur dioxide contribute to the formation of acid rain. In environmental impact terms, the burning of petrol in an internal combustion engine produces more carbon dioxide than does diesel, which in turn produces more nitrates/nitrites and sulfates/sulfites than petrol. With improving diesel refining techniques, sulphur levels are being reduced, thereby improving the overall profile of diesel as a transport fuel in comparison to petrol.

Electricity related environmental effects include the possible presence of potentially carcinogenic polychlorinated biphenyls (PCBs) in old transformers and capacitors, as well as electromagnetic fields from high voltage power lines, considered possibly carcinogenic and suspected to correlate with higher incidences of spontaneous abortions in extensive international studies.

8.3.6 Key energy issues in CTMM

- CTMM is already implementing measures which will improve energy service delivery and improve the Municipality's contribution to management of South Africa's environment.
- The most energy intensive sector in CTMM is the transport sector. Key areas of vehicle generated emissions have been identified. The introduction of the Gautrain in 2010 is anticipated to reduce vehicular traffic in the southern parts of Tshwane toward the rest of Gauteng.
- Industry and households also contribute to undesirable emissions in CTMM.
- There is an apparent geographic imbalance in CTMM's electricity network maintenance, posing a medium-term threat to reliability and financial sustainability.
- Energy services for low-income households have historically been inadequate.
- Households suffering unemployment and poverty rely on less convenient and often unhealthy fuels, which also have a deleterious effect on the environment. Eskom is rolling out the use of CFLs in selected areas within Tshwane, which can provide a building block for CTMM energy efficiency measures.
- There are no significant renewable energy, energy efficiency and demand side management programmes within Tshwane yet. Residential solar water heaters could represent a good starting point.
- Tshwane's landfill sites and solid waste management represent CDM as well as additional energy generation opportunities.
- Most decisions on the choice of household energy carriers are taken by women.
- Illegal electricity connections are a problem both in terms of danger of electrocution and in terms of reduction of revenue for the Municipality, as well as a drain on the Municipality's human resources to resolve the situation.
- Coal use in urban areas results in indoor air pollution as well as adding to South Africa's net contribution to CO_2 emissions, and therefore to climate change.
- Energy security for low-income households can help reduce poverty, increase livelihoods and improve living standards.
- Few alternatives to fossil-fuel burning vehicles are available to CTMM's population, although improvements in the refining process are resulting in more environmentally-friendly, reduced-emissions diesel. With national legislation banning the use of leaded fuel by 2006 being implemented and the cost of fuel rising, alternative technologies are being introduced in South Africa with an expectation that market forces as well as "environmental goodwill" will drive their use.
- Tshwane's power generation park is old and in need of significant maintenance and refurbishment funding. Consideration should be given to alternative generation means.

8.4 RECOMMENDATIONS

The Energy Strategy should be developed on the basis of these issues identified above. It should be developed using a Service Delivery Framework, described in Section 8.2, which acknowledges the inter-related activities of setting Policy & Strategy, translating these strategy elements into specific Planning & Design and then rolling out the infrastructure service through Operation & Maintenance. Through feedback between these steps, policies and strategies can be refined with experience, and planning and design can be improved to take into account lessons learned – with a resultant enhancement in operation and maintenance.

The Service Delivery Framework can therefore serve as a guideline to establish desired outcomes, key performance indicators, data collection requirements, data collection protocols, data provision and performance agreements, monitoring framework for data collection across the range of energy demand sectors and energy carriers. Critical focus areas for data collection should be the transport and household demand sectors.

CTMM has already taken the most important step of engaging an Energy Specialist to develop an integrated approach to energy in Tshwane.

It is recommended that the Energy Strategy be developed using the Service Delivery Framework as a guideline to establish:

- Desired outcomes
- Key performance indicators
- Data collection requirements
- Data collection protocols
- Data provision and performance agreements
- Monitoring framework for data collection

Across the range of energy demand sectors and energy carriers. Critical focus areas for data collection should be the transport, industrial and household demand sectors.

Recommendations in the areas of electricity, liquid fuels, environmental issues and the collective of Renewable Energy (RE), Energy Efficiency (EE) and Demand Side Management (DSM) are presented in Table 45 overleaf.

Table 58 Recommendations

Electricity	o Environmental issues
o Further community awareness programmes on the dangers of electricity theft should be implemented.	o CTMM should establish an integrated environment and energy program to develop and roll out its Energy and Climate Change Strategy.
o Further community awareness programmes on the need for electricity services to be paid for should be implemented.	o CTMM should link its transport activities to the Gauteng Province's vision, providing feedback to the province about the significant effect which transport has on the environment in Tshwane.
o An automated energy balance, integrating information from the Venus system, should be established. Further training should be planned for financial personnel to ensure adjustments to financial information are correctly reflected in technical adjustments.	o CTMM should engage in focused data collection to assess trends in diesel versus petrol vehicle purchase and use in CTMM in order to establish baseline emissions data and forecast trends. It should also consider recommending to the Department of Transport that future vehicle registrations note the vehicle fuel type.
o Regular audits of this adjustment process, involving CTMM Electricity personnel should be carried out.	o CTMM should establish a dedicated air quality monitoring program at selected locations in the path of sources of particulate emissions and greenhouse gases within its boundaries to gather data which could be used to assess seasonal effects.
o An independent audit of electricity information should be carried out.	o The extent and location of residual PCB contaminated oil (if any) in CTMM electrical facilities should be assessed and an action plan drawn up to dispose of the remaining chemicals.
o The difference in consumption growth between electricity and IP for lighting should be examined in more detail.	o CTMM electricity and health staff should ensure they are well-informed on ongoing research on the subject of the health effects of electromagnetic fields from high voltage transmission lines.
o CTMM should encourage skills development to satisfy its own capacity requirements.	o Renewable Energy (RE), Energy Efficiency (EE) and Demand Side Management (DSM)
Liquid fuels	o
o Further studies should examine losses in the supply chain and assess areas where demand may	o CTMM should develop showcase RE, EE and DSM projects within local government with the aim of educating

be suppressed due to distance from supply.	the public and businesses on how to implement "quick wins" as well as longer term measures. A pilot household Solar Water Heater (SWH) project could be used to great advantage both for developing energy awareness and for achieving reduction in electricity demand.
o The trend in consumption of diesel and petrol should be examined in terms of influence of energy efficiency incentives.	o CTMM should link into the DME's current initiatives in these fields and build on the current EE marketing campaign being implemented in the Municipality.
o CTMM should carry out a vehicle survey in order to establish the number of diesel and petrol vehicles "in" the city, versus the number "travelling through". This could be carried out through a combination of simulation and field measurements.	o Within the context of the REDs and in collaboration with National Government, CTMM should consider developing tariff-based incentives for the implementation of EE and DSM measures, as well as capital subsidy packages for RE measures.

General

- Many of these initiatives, particularly in the Transport sector, will need to be carried out in collaboration with the Gauteng Provincial Government as well as with Departments within the National Government. The overarching Energy Strategy, to be developed in the next phase of this project, will be the base from which this collaboration can be achieved.

For GHG emission estimates:

A more comprehensive and dynamic analysis of GHG emissions is required in order to generate an effective strategy. This should include:

a. More data on non-energy sources of methane, e.g.:
   i. volumes and type of agricultural waste, if any
   ii. industrial effluent and municipal sewage treatment emissions
   iii. volumes and specific contents of landfills, as well as annual rates of addition.
b. Analysis of vehicle information to corroborate static estimates of GHG emissions from transport fuels.