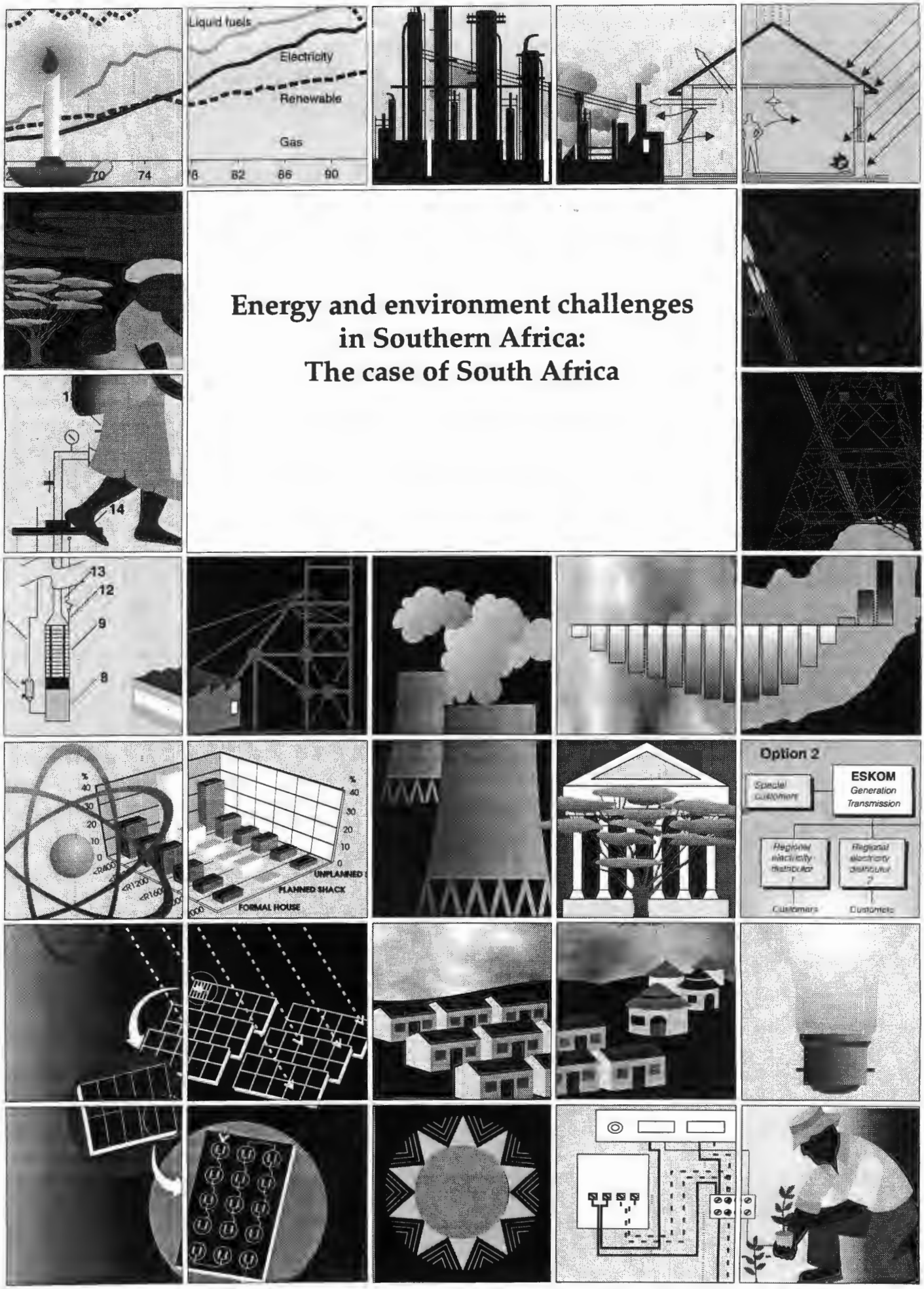


# Energy and environment challenges in Southern Africa: The case of South Africa


**EDRC REPORT SERIES**

ENERGY & DEVELOPMENT RESEARCH CENTRE

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## CHAPTER ONE

# Introduction

### 1.1 Background

This paper is part of a broader study, the Southern African Energy and Environment Programme (SAEEP). This is a collaborative study between the Centre for Energy, Environment, Science and Technology, Tanzania; the Centre for Energy, Environment and Engineering, Zambia; the Energy and Development Research Centre, South Africa; the Southern Centre for Energy and Environment, Zimbabwe; and the Fridtjof Nansen Institute in Norway.

The primary objectives of the project are firstly, to identify the energy-related environmental problems (EREPs) facing South Africa, Tanzania, Zimbabwe and Zambia. Secondly, the project aims to provide a comparative analysis of how these four countries have sought to overcome EREPs in their societies. This involves an analysis of the effectiveness of the various strategies that have been used in the different countries to overcome EREPs in order to contribute to the understanding of factors which militate against or support the sustainable production and use of energy resources in these countries. Thirdly, the project aims to contribute to the development of policy studies in the collaborating centres on how states and societies can manage environmental concerns in the energy sector. This report focuses on these issues in the South African context.

### 1.2 Energy issues in the apartheid era

Prior to the transition to democracy in South Africa in 1994 and the Government of National Unity's introduction of the Reconstruction and Development Programme (RDP), energy planning and the provision of energy services in South Africa was fraught with problems so severe that it impacted both directly and indirectly on the energy situation in the Southern African region. Thus, the regional energy situation required reassessment as a whole.

Despite the availability of a large energy resource base, a number of factors contributed to the general decline related to the energy crisis in the Southern African region. The oil crisis in the early 1970s led to increased debt in Southern Africa as a whole. The recession in South Africa in the 1980s, largely due to investments sunk in the expansion of domestic energy activities, enhanced the regional energy decline.

Under apartheid rule, South Africa was actively engaging in military attacks on energy installations in Southern Africa. Its most frequent targets were Angola and Mozambique. The United Nations and the Organisation of African Unity therefore called for the 'breaking of diplomatic relations with South Africa, an arms and oil embargo and the suspension of all nuclear co-operation' (Eleri 1994:48).

South African apartheid energy planning also contributed to environmental degradation. In its quest for energy self reliance, it embarked on massive development of its coal resources for electricity generation and the production of synthetic fuel for transportation. Further investments were made in the local nuclear industry. These large investments had far-reaching environmental implications for the country. These, however, played so small a role in decision-making as to be negligible. Energy policy in the apartheid era did not consider environmental issues in any significant way (Eleri 1994:48). There was no clear national policy to guide the actions of the different sectors. Energy-related environmental problems (EREPs) tended, therefore, to be defined (if at all) by those with political and economic power, rather than by the majority of people whose daily lives were seriously affected by the use of their energy resources.

The provision of energy services and planning in South and Southern Africa needs to be reviewed and examined from a different perspective. Energy planning should be positively addressed by the formulation of a new energy policy which incorporates principles of efficiency, coordination, social equity and environmental sustainability.

### 1.3 Energy planning in a democratic South Africa

The African Naitional Congress (ANC), the majority party in power in South African, has committed itself to redressing the inequalities of the past system of government. To this end, they have introduced the Reconstruction and Development Programme, an integrated socio-economic policy framework which seeks to eradicate apartheid and build a democratic future. The goals of the South African RDP include:

- meeting basic needs;
- developing South Africa's human resourses;
- building the economy;
- democratising the state and society (ANC 1994).

Within this framework, there are a number of indirect and direct policy aims which relate to issues around energy and environment or afford opportunities for reducing energy-related environmental problems. These include:

- the promotion by the RDP of sustainable development, through a balance between concerns of social equity, economic development and environmental sustainability;
- the commitment by the government to providing one million new houses by the year 2000;
- the commitment by the government to providing 2.5 million new connections in the same time frame; and
- energy efficiency and conservation are to become the cornerstones of all energy policy (ANC 1994).

Thus, within the context of South Africa's present political climate, there is a great opportunity to review energy planning and to create new policy which integrates energy efficiency, social equity and environmental sustainability.

### 1.4 Structure of the report

Chapter 2 of this paper provides an overview of the South African economy and its relationship to the provision and use of energy in the country. It further attempts to measure the country's development priorities against energy-environment priorities and briefly considers the stakeholders involved in determining such priorities.

Chapter 3 discusses energy-related environmental problems at the household, national, regional and global scales. It defines the nature of each problem and identifies the stakeholders involved in each. It further outlines government policies, programmes and pojects associated with each problem and assesses the impact of certain actions embarked upon in relation to the energy-environment problems.

Chapter 4 analyses the energy-related environmental problems identified in chapter three, evaluating the different options for ameliorating their impacts at the four levels – household, national, regional and global. The opportunities for and barriers to the implementation of each option are discussed and recommendations and directions for future research are presented. Finally, the chapter identifies directions for future research.

CHAPTER TWO

# Development, energy and institutions in South Africa

The transition to democracy in South Africa has brought with it an emphasis on reconstruction and development, with the central goals of enhancing the performance of the economy and, at the same time, distributing the benefits of the country's wealth more widely. Efforts are being made in all sectors of society to initiate new projects, or to redirect existing activities, in order to support the objectives of the government's Reconstruction and Development Programme (RDP).

In the light of this overwhelming shift towards `development' priorities, some might expect that `environmental' goals have been relegated to a lower priority on the national agenda. This, however, is not the case, for two main reasons. Firstly, environmental issues have never enjoyed a particularly high priority in national policy-making or research, except in terms of narrow definitions of the environment related to nature and wildlife conservation. If anything therefore, environmental issues as they concern the quality of peoples' living environments have always been a low priority and so cannot be said to be further relegated now.

The second reason why environmental issues are becoming more important, is because of the recognition that some of the most serious development problems the country faces are in fact also environmental problems. This is especially true in the energy sector, although the same holds true in other sectors.

This chapter provides an overview of the South African economy and its relationship to the provision and use of energy in the country. It further attempts to measure the country's development priorities against environment priorities and briefly considers the stakeholders involved in determining such priorities.

## 2.1. Demography

Figure 2.1 below depicts South Africa in its Southern African context and presents the climatic zones of the region. The country covers an area of 1 223 201 km$^2$. According to the Development Bank of South Africa (DBSA), the country's total population numbered 40.7 million in 1993, having grown at a rate of 2.44% since 1985 (DBSA 1994: 17). Population density is about 33 persons per km$^2$. The country's population structure is quite diverse.

The DBSA estimates that in 1993, 48% and 65% of South Africa's total population was respectively urbanised and functionally urbanised (DBSA 1994: 17). Functional urbanisation is defined to include people living in areas adjacent to formal towns (eg informal settlements) or in settlements where more than 5 000 people reside but have not yet attained town status.

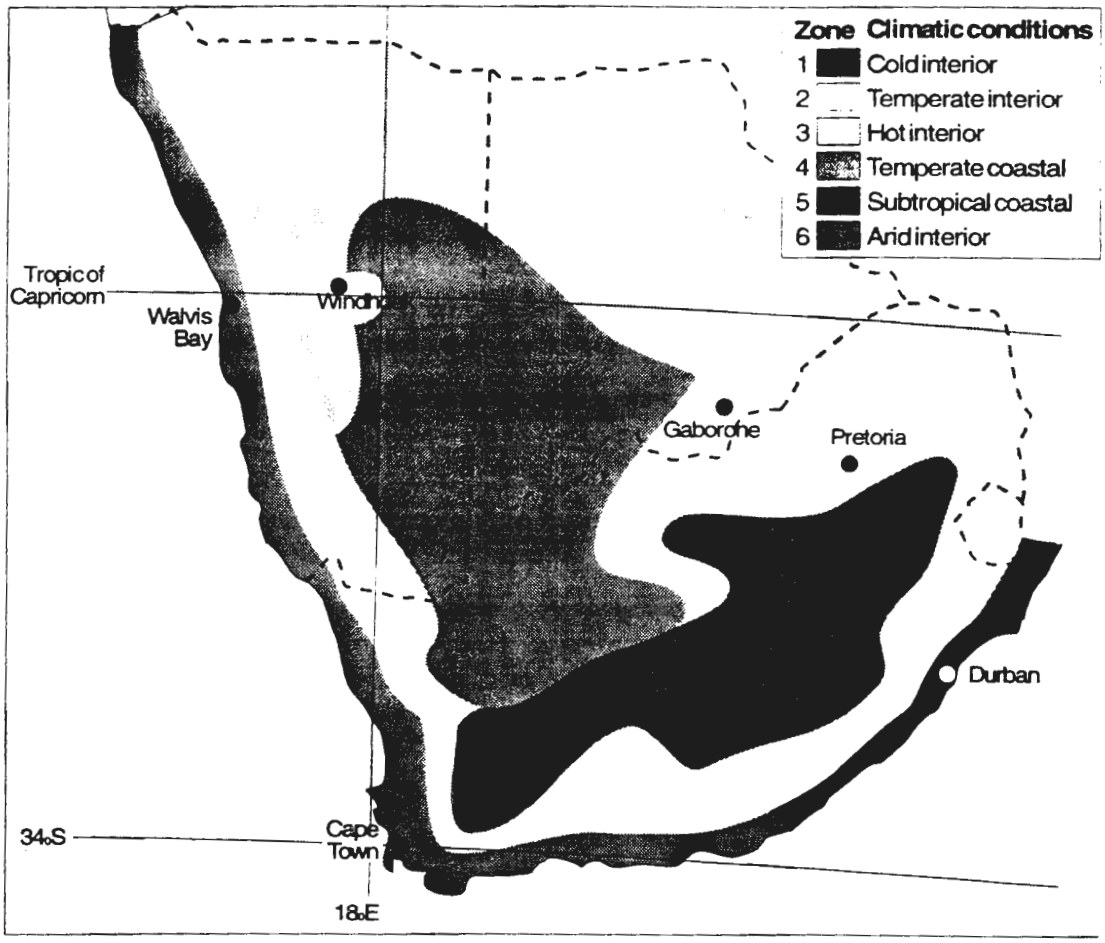


**Figure 2.1** Climatic zones of Southern Africa
(Demarcation is approximate only)

## 2.2. Economy

According to the South African Institute of Race Relations, estimates of South Africa's economic growth rate for 1994 ranged between 2% and 3% (SAIRR 1994: 378). The Central Statistical Services (CSS) estimates real economic growth, as measured by Gross Domestic Product (GDP) at constant 1990 prices, to have been 1.4% in 1993, compared with declines of 2.4% in 1992, 1.1% in 1991 and 0.8% in 1990 (CSS cited in SAIRR 1994). An economic growth rate of between 2% and 3.2% is predicted for 1995. Figure 2.2 represents real GDP by kinds of economic activity from 1990 to 1993.

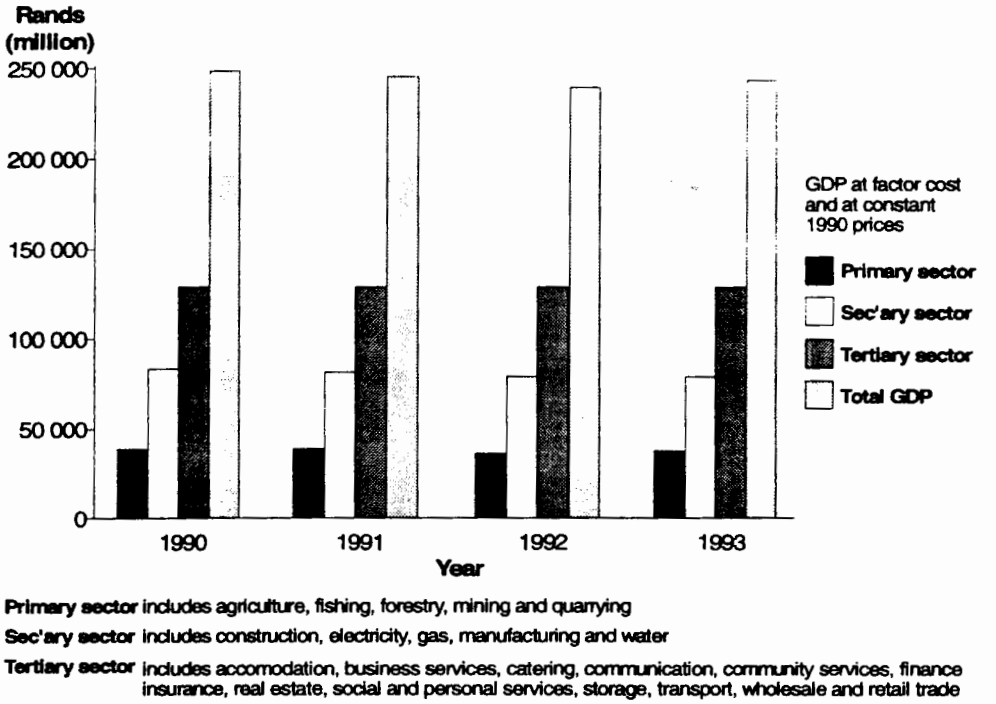


**Figure 2.2** Real GDP by kinds of economic activity: 1990-1993
*(Source : SAIRR, 1995)*

An annual average growth rate of 0.9% in real GDP from the 1982 to 1993 fiscal years is recorded against an annual population growth of 2.4% for the same period. This resulted in a decrease of 18.8% in real GDP per capita over this fiscal period, from R8 397 (US$2 332) to R6 821 (US$1 894).

Table 2.1 gives a breakdown of GDP at constant 1990 prices by kinds of economic activity from 1982 to 1993.

| YEAR | PRIMARY SECTOR[b] (R* m) | SECONDARY[c] SECTOR (Rm) | TERTIARY SECTOR[d] (Rm) | TOTAL GDP (Rm) | %INCREASE or (DECREASE) |
|---|---|---|---|---|---|
| | | | | | |
| 1982 | 35 523 | 81 969 | 107 244 | 224 736 | (0.6) |
| 1983 | 33 205 | 77 164 | 110 029 | 220 399 | (1.9) |
| 1984 | 35 104 | 80 301 | 116 664 | 232 069 | 5.3 |
| 1985 | 37 037 | 76 890 | 116 007 | 229 935 | (0.9) |
| 1986 | 36 864 | 76 325 | 116 602 | 229 791 | (0.06) |
| 1987 | 35 991 | 77 391 | 120 621 | 234 003 | 1.8 |
| 1988 | 36 745 | 82 033 | 124 447 | 243 225 | 3.9 |
| 1989 | 38 290 | 83 959 | 126 943 | 249 192 | 2.5 |
| 1990 | 37 095 | 82 474 | 127 746 | 247 315 | (0.8) |
| 1991 | 37 149 | 79 401 | 127 999 | 244 549 | (1.1) |
| 1992 | 33 830 | 76 976 | 127 905 | 238 711 | (2.4) |
| 1993 | 36 471 | 76 895 | 128 635 | 242 001 | 1.4 |

a *Gross domestic product at factor cost and at constant 1990 prices. Figures may not add up owing to rounding*

b *Includes agriculture, fishing, forestry, mining and quarrying*

c *Includes construction, electricity, gas, manufacturing and water*

d *Includes accommodation, business services, catering, communication, community services, finance, insurance, real estate, social and personal services, storage, transport, wholesale and retail trade*

**Table 2.1** Real GDP by kinds of economic activity [a] (1982-1993)
*(Source : SAIRR, 1995)*

It has been estimated that the formal economy would have to grow between 8% and 9% annually from 1995 to 2011 if the anticipated labour force of 9.5 million economically active people are to be absorbed (SAIRR 1995)

Despite an increase in economic growth and activity, formal sector employment continued to decline in 1993. The unemployment rate which includes people working in the informal sector, increased from 18.5% in 1991 to 29% in 1993 (The South African Reserve Bank 1994). When the informal sector is included in this figure, unemployment is close to 50%.

There is a big disparity between high and low-income groups in South Africa. The richest 10% of households in the country earned 51.2% of total income and the poorest earned 3.9%. Almost 41% of all households in the country lived below the minimum household subsistence level (University of Natal 1994 cited in SAIRR 1995). Personal income per capita was around R2 566 in 1991 (DBSA 1994).

### 2.2.1 Energy consumption - GDP linkages

Eberhard and Trollip (1994: 19) state that 'the historical trends for industrialised countries suggest that, as the structure of economies change from one of domination by primary industries to larger commercial and service sectors, the energy / GDP ratio tends to reach a peak and then decreases so that many industrialised countries currently experience decreasing energy usage with increasing economic output'.

In Figure 2.3 below South Africa's primary energy consumption is compared with other selected countries. The country has an above average energy intensity i.e. more energy is used

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* *Note : An exchange rate of USD1 = R3,60 has been used throughout this report.*

per unit of economic output than in many other countries. Only ten countries have commercial primary energy intensities higher than South Africa (World Bank 1990).

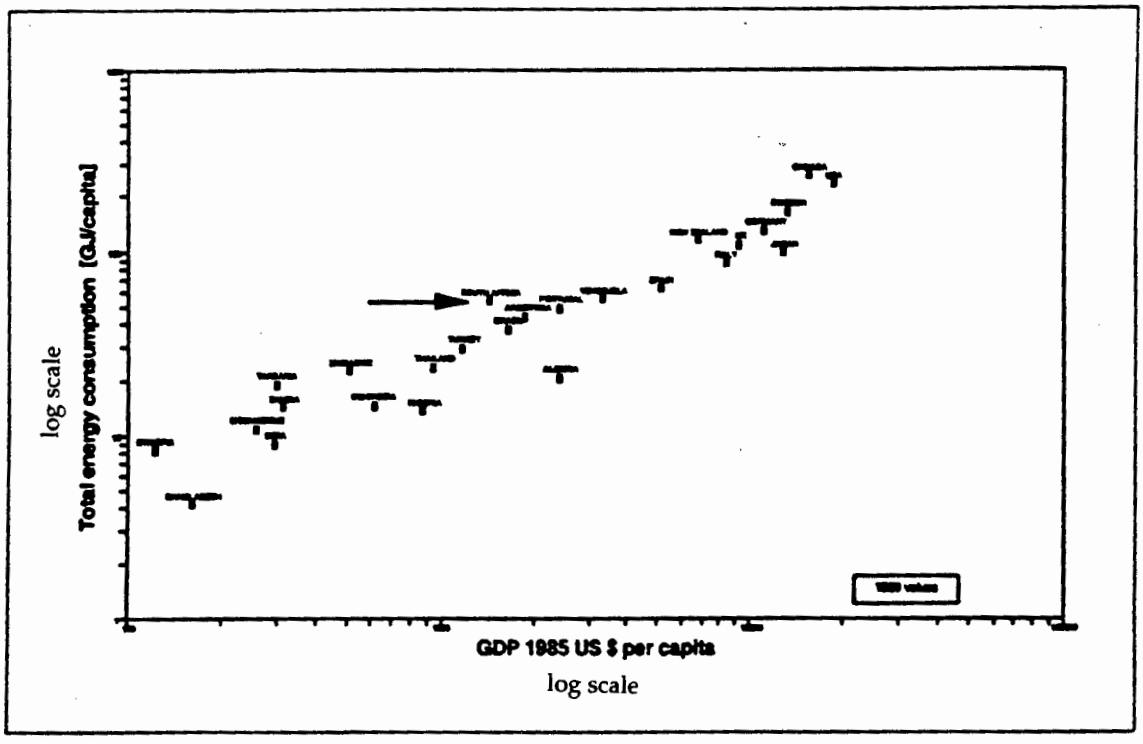


**Figure 2.3** Energy consumption per capita versus GDP per capita for selected countries - 1989
*(Source : Eberhard and Trollip 1994)*

Eberhard and Trollip (1994: 20) point out that developed economies have shown a steady decline in energy intensity as the structure of these economies became less reliant upon heavy resource-based industry. Since the increase in the oil price in the 1970s, significant improvements in energy efficiency and conservation have been achieved, contributing to a sharper decline in energy intensity in industrialised economies where the growth in energy consumption has been slower than the growth in economic output. It is clear from Figures 2.4 and 2.5 that the same trend is not yet noticeable in developing economies generally and in South Africa, specifically.

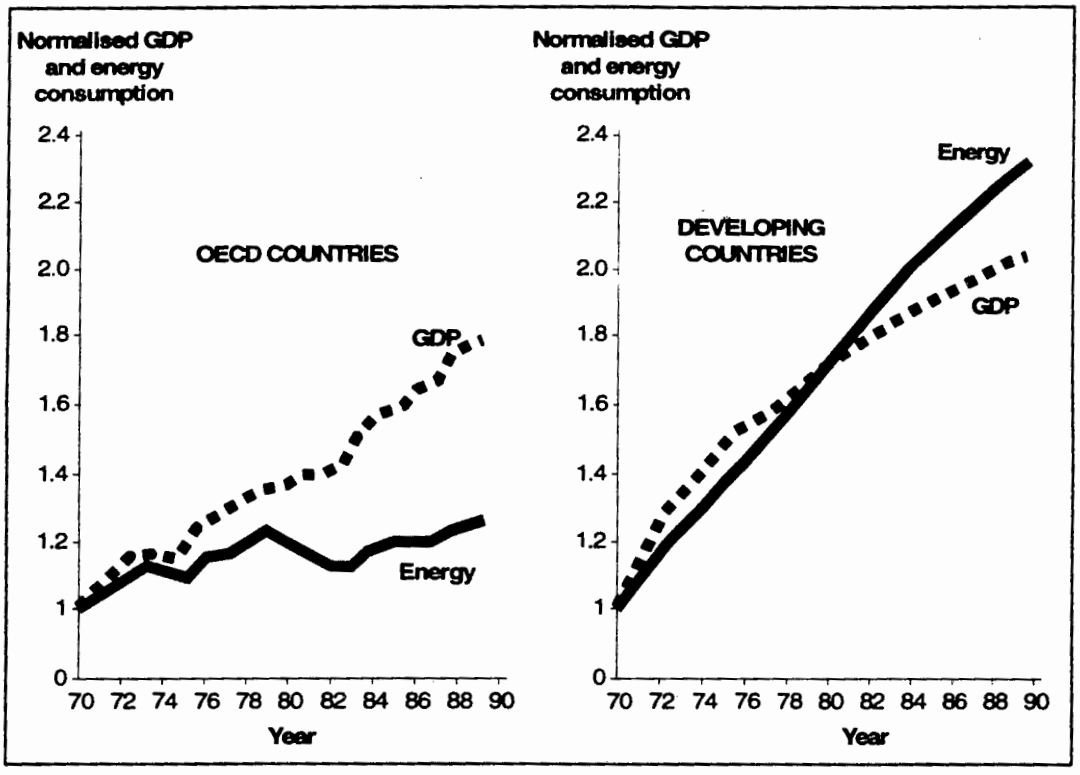


**Figure 2.4** Trends in net commercial energy consumption and GDP growth *(Source : Munasinghe in Eberhard & Trollip 1994)*

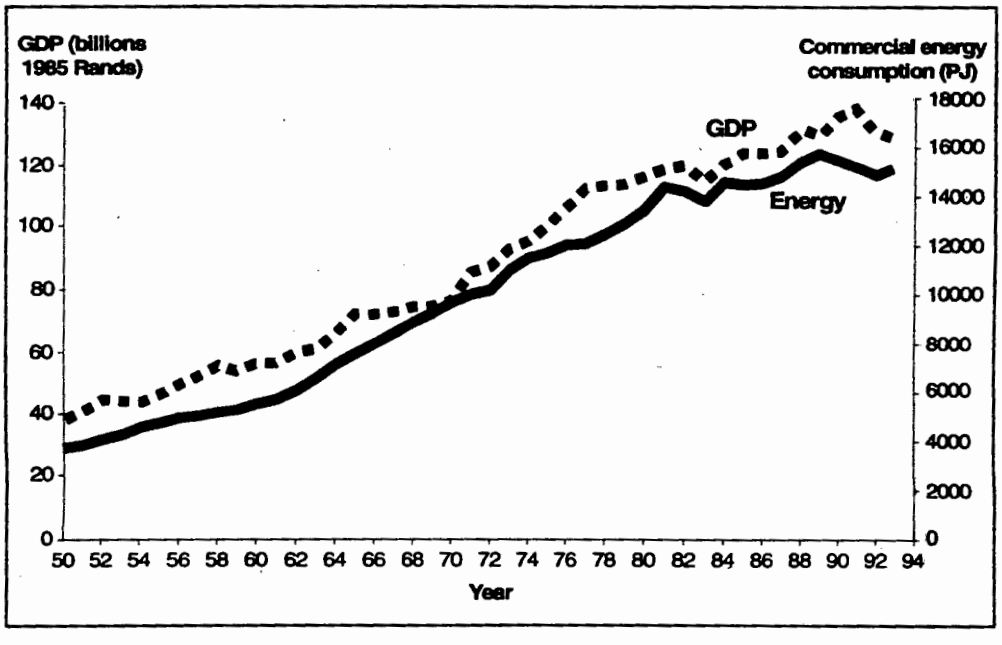


**Figure 2.5** Net commercial energy consumption and GDP growth in South Africa (1950-1993) (Source: Gielink and Dutkiewicz 1991 in Eberhard and Trollip 1994)

An alternative way of looking at energy-GDP linkages is to examine what Rustomjee (1992) referred to as the minerals-energy complex which includes mining, minerals beneficiation and energy production. He estimated that if mineral-energy complex activities were removed from the standard 'manufacturing' classification in GDP statistics, then manufacturing had not grown much. In fact, it has remained within a narrow band of 15% to 17% of GDP since 1960.

Rustomjee states that R35.9 billion (63%) was contributed to exports by the minerals-energy complex in 1989. Gold accounted for roughly half of this and coal about 10%. Direct commercial energy production, which is nearly all coal-based, is largely for the domestic market and contributes minimally to exports. South Africa is thus mainly a resource-based economy and coal mining exports and fuels and electricity production are very significant.

## 2.3. Energy resources

Energy resources in South Africa comprise coal, gas, hydro-electricity, nuclear energy, biomass, solar and wind energy. Figure 2.6 represents South Africa's primary energy consumption by supply sector.

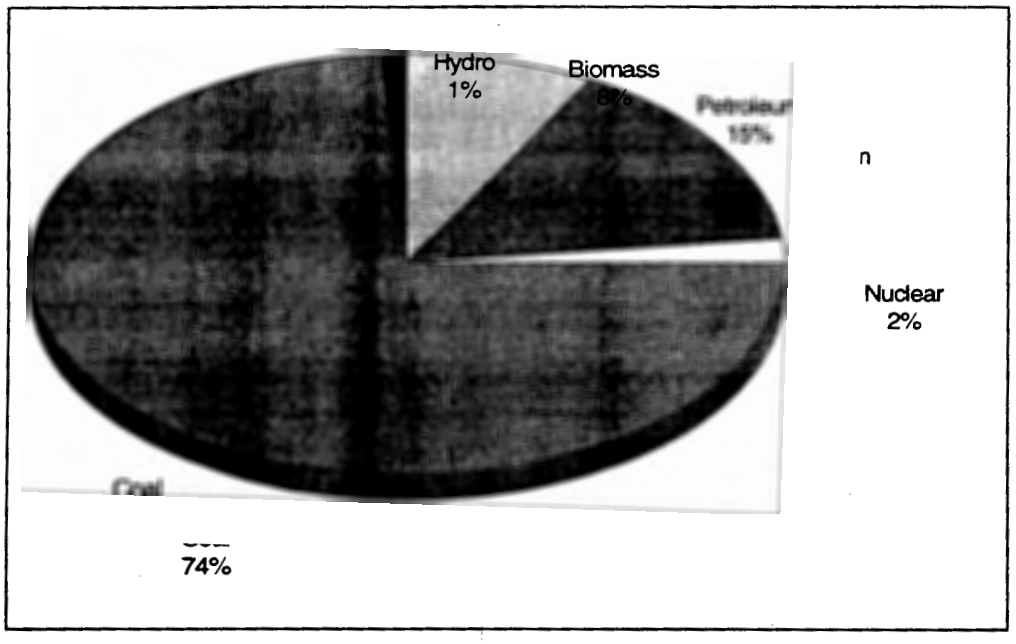


**Figure 2.6** South Africa's primary energy consumption by supply sector, 1989
*(Source: Eberhard and Trollip, 1994)*

### 2.3.1 Coal

It is clear from the figure that coal is by far the largest source of energy in South Africa. Extensive deposits of bituminous coal can be found in the Eastern Transvaal, the northern Orange Free State and northern Kwazulu/Natal regions of South Africa. These deposits are easily accessible being close to the surface which facilitates mining at very low cost.

According to Gielink and Dutkiewicz (1993) coal reserves in place amount to 121 000 million tons of which 55 333 million are currently estimated to be economically recoverable. They are believed to be the fourth largest reserves in the world and 10% of the estimated world inventory.

The mining and beneficiation processes of coal leave considerable quantities of discards which are presently not exploited. The possibility of utilising these coal discards in low-smoke fuel production, or other related processes is being investigated and, if successful, would significantly improve the efficiency of coal utilisation and extend the coal reserves even further.

### 2.3.2 Hydro-electricity

South Africa has a hydro-electric potential of 3500 MW of which 540 MW has been exploited (Gielink & Dutkiewicz 1993). Hydro-electric potential in the country is limited because the river flow rates are relatively small. Long droughts lasting up to 8 years as well as floods of relatively short duration are experienced. Also, the construction of dams to regulate the highly variable volumes of water, is a costly exercise.

South Africa's hydro-electric potential is suitable only for low load factor operation. Its existing conventional hydro-electric schemes are mainly used as peaking stations and for synchronous condenser operations. The country also has two pumped storage hydro schemes used exclusively to meet peak demand.

### 2.3.3 Petroleum and gas

A large portion of South Africa's crude oil requirements are imported (Gielink & Dutkiewicz 1993). However, some indigenous coal and gas are used as feedstocks for its liquid fuel requirements. The South African government-funded Southern Oil Exploration Company (SOEKOR) has located a number of small offshore oil fields. Its exploration has not proven to be economic to date.

Mossgas, off Mossel Bay in South Africa's southern Cape region, is believed to have gas reserves of 28 000 million $m^3$ (Gielink & Dutkiewicz 1993: 15). These form the feedstock for the Mossgas project where it is converted to synfuel. The project supplies 10% of South Africa's liquid fuel requirements. The economic viability of this project and cost to the South African taxpayer has been in question since its inception.

### 2.3.4 Nuclear energy

Nuclear energy constitutes only 2% of primary energy consumption. In the 1980s, low uranium prices resulted in production cut-backs and stalled all planned expansion of the nuclear industry. 98% of uranium production is recovered from gold mining making the availability of uranium dependent on gold production which is unlikely to expand its operation in the future. According to Gielink and Dutkiewicz (1993), South Africa has 432 000 tons of uranium reserves recoverable at less than 130 US$/kg, constituting 15% of the western world's reserves. Uranium production was 3 500 tons in 1989 of which 90% was available for export.

### 2.3.5 Biomass

Fuelwood is derived from six different sources: commercial exotic plantations, alien vegetation eradication, self-seeded exotics, woodlots, indigenous forests, and natural shrubland or woodland (Gielink & Dutkiewicz 1993: 14). The extent to which the first five fulfil users' demand is negligible.

Dung is used to supplement and in some instances, substitute for fuelwood in many rural areas of South Africa. Eberhard (1990) estimated that the net use of dung in underdeveloped areas in the country amounts to 34kg (1,42 GJ) per capita per annum.

The potential exists for the use of organic refuse as a source of energy either through direct combustion or by conversion to biogas via microbiological processes. A further potential source of energy is methane gas from sewerage treatment works. A cyanide factory in South Africa operated by the AECI company utilises methane gas originating from sewerage purification works and refuse dumps.

### 2.3.6 Solar and wind energy

Figure 2.1 indicated South Africa's climatic zones. With the exception of the coastal belt areas, the country generally has a sunny climate. Gielink and Dutkiewicz (1993) estimate that the average annual insolation is highest in the north-western semi arid region of the country where it averages 6 000 $Wh/m^2$ /day but declines towards the southern coastal areas (5 000 $Wh/m^2$/day) and eastern coastal areas (4 500 $Wh/m^2$ /day). It is further estimated that virtually the entire interior of the country has an average insolation in excess of 5000 $Wh/m^2$/day and a large portion has an average insolation of between 5 500 and 6 000 $Wh/m^2$/day. There is thus a large potential to exploit solar energy further. More extensive use of solar water heaters could contribute to considerable savings in the domestic use of electricity. Photovoltaic electricity can play an important role in the supply of power to remote areas removed from the grid.

Wind energy could be exploited along the coastal belts of South Africa, particularly along its southern and south-western Cape coasts where mean annual wind speeds are in excess of 4 m/s. Inland areas of the country have relatively low wind energy potential. Wind energy has, however, been used in South Africa to pump water in rural areas. Wind generation in the form of stand-alone systems can play an important role in remote areas where they can be used on their own or in photovoltaic/wind/diesel hybrid systems.

## 2.4. Energy end-use

Figure 2.7 illustrates relative energy demand by major consumer groups in South Africa. The industrial and commercial sectors account for nearly half of the country's energy consumption and the transport and household sectors together account for a considerable percentage of energy demand.

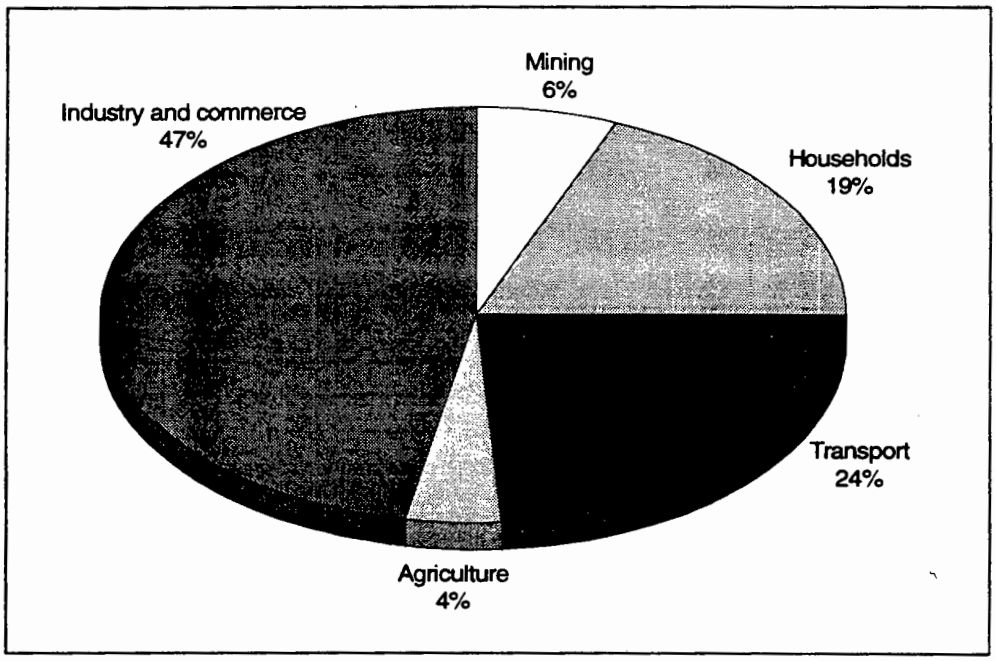


**Figure 2.7** Net energy consumption by major consumer groups in 1989
*(Source: Eberhard and Trollip 1994)*

Figure 2.8 shows the structure of the demand for energy by types of fuel in each major consuming sector.

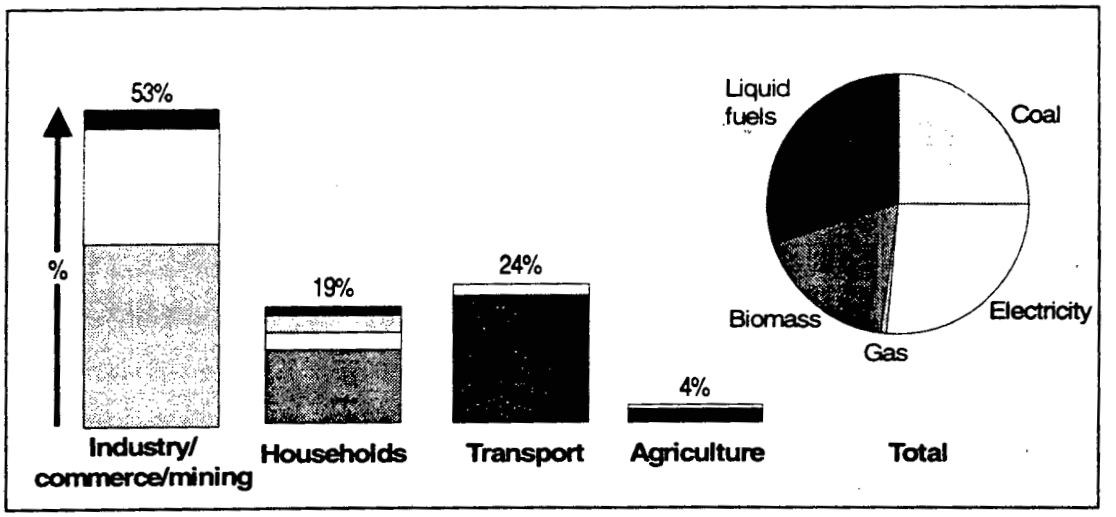


**Figure 2.8** Structure of the demand for energy by types of fuel in each major consuming sector - 1989
*(Source: Eberhard and Trollip 1994)*

Eberhard and Trollip (1994) point out that in terms of economic development, electricity is acknowledged as being of particular importance. The percentage of electricity utilised by different sectors is shown in Figure 2.9.

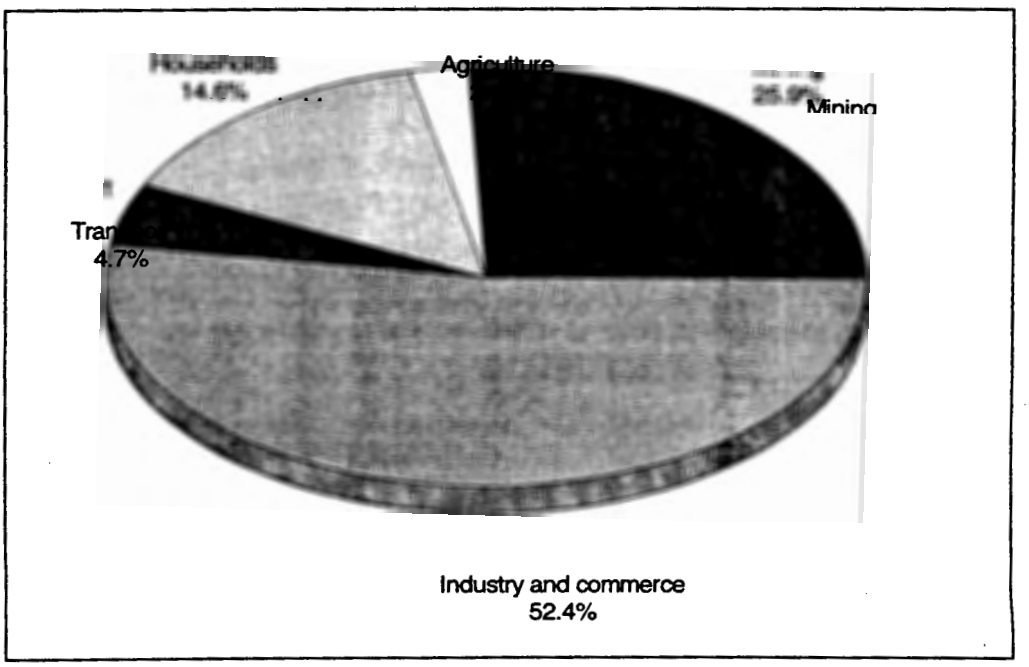


***Figure 2.9*** Sectoral consumption of electricity in South Africa in 1989
*(Source: Eberhard and Trollip 1994)*

The industrial, commercial and mining sectors together account for more than three quarters of electricity consumption followed by the household sector which accounts for 14.6% of electricity usage. The cost of electricity and coal, its primary source, is relatively low in South Africa (see Figure 2.10).

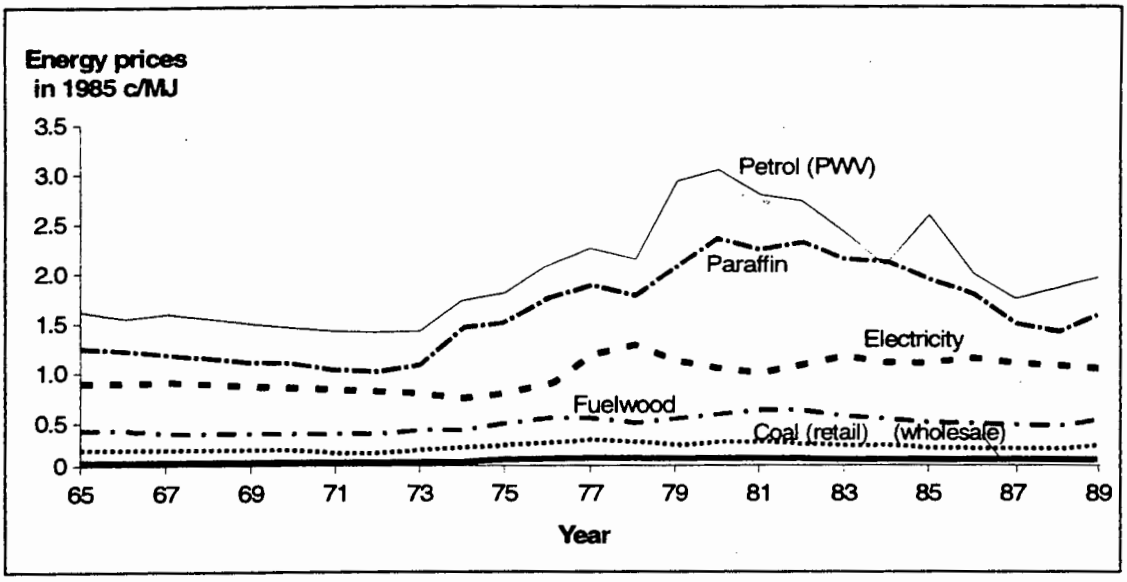


**Figure 2.10** Average energy prices for different fuels
*(Source : Eberhard and Trollip 1994)*

Fuelwood is the main energy source utilised by rural households. While fuelwood from natural woodland is generally free to harvest, it bears a heavy social cost in time and effort during collection. Where woodland is scarce, rural households have to pay for fuelwood. In this case, the cost of transporting fuelwood from other areas is added to the price of the fuel making it more expensive than coal. Coal also provides multiple utility, which contributes to its cost-effectiveness and efficiency.

Figure 2.11 shows the daily demand curve on the day of peak electricity demand on the national grid in 1992. The graph indicates that peak demand occurred at 18h00 on a cold day and coincided with the peak demand of domestic users. The significance of this is discussed in Chapter 3 under the household scale.

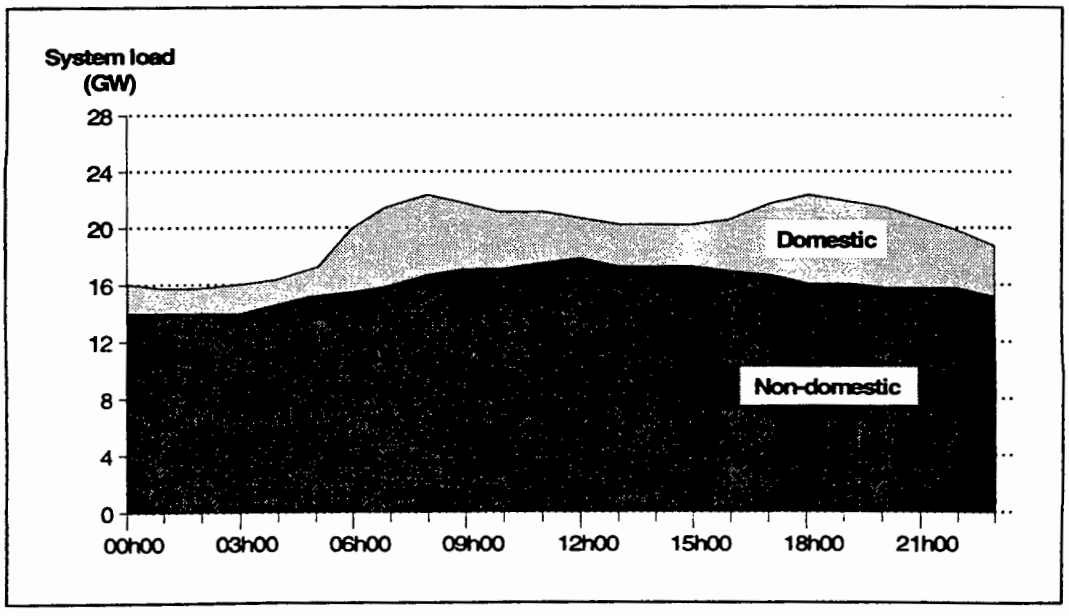


**Figure 2.11** South African electricity system demand on day of peak demand (1992)
*(Source : Berrisford and Bluff in Eberhard and Trollip 1994)*

At the end of 1994, there were close to 8.4 million households in South Africa with an average size of 4.6 people. Of these, 44% were estimated to have access to electricity, equavalent to

40% of the total population. The proposed number of household connections to be made between 1994 and the year 2000, is estimated at 2.5 million supplying electricity to between 400 000 and 450 000 households annually (Davis 1995: 1). The country's Reconstruction and Development Programme aims to facilitate the construction of a million new homes by 2000 (ANC 1994: 22), which could have a huge impact on energy consumption.

## 2.5. National energy and development priorities

It was stated at the outset of this chapter that South Africa's new democratic government is emphasising reconstruction and development, with the central goals of enhancing the performance of the economy and, at the same time, distributing and redirecting the country's wealth more widely. This section discusses South Africa's national budget in relation to budgetary allocations made to national departments responsible for the planning, administration and management of energy and environmental affairs. Figure 2.12 represents the functional classification of South Africa's national expenditure for the 1995/96 fiscal year, budgeted at R156 912 billion. Apart from this amount, a separate expenditure account exists for the Reconstruction and Development Programme (Department of Finance 1995).

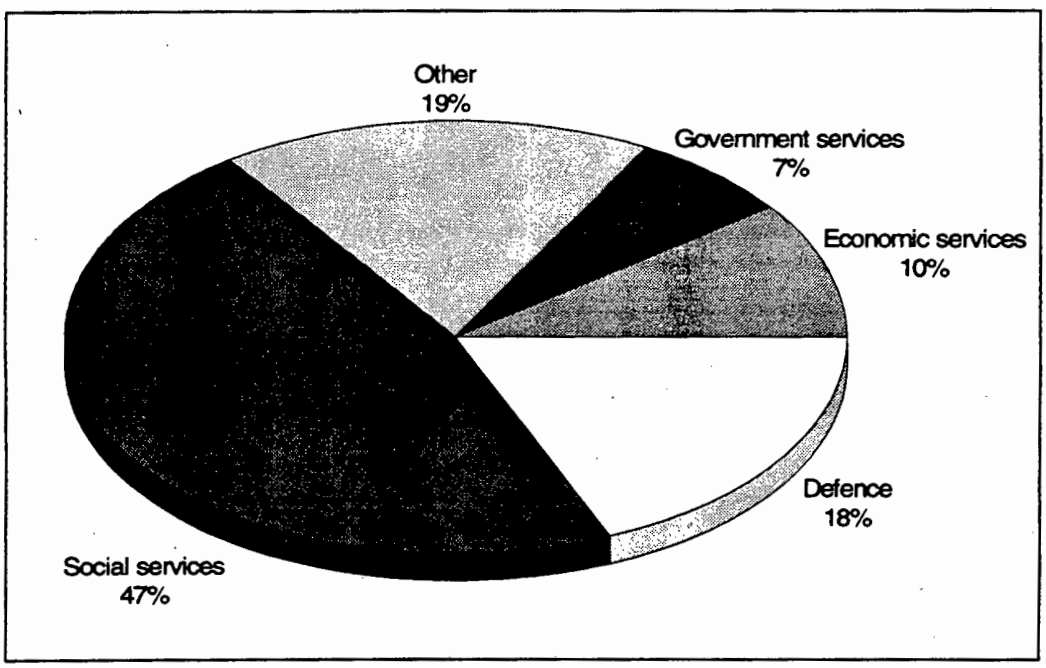


**Figure 2.12** Functional classification of general government expenditure - 1995/96
*(Source: Department of Finance, March 1995)*

The largest portion (46%) of the budget is allocated to social services which include the provision of health, education, social security and welfare, housing and related services, recreation and culture. The expenditure allocated to social services complements the government's commitment to the development of underdeveloped areas which is explicitly stated in its Reconstruction and Development Programme.

RDP funds are allocated to two purposes. Firstly, to fund 'presidential lead projects' which include, among others, national nutrition programmes for underfed children, rural water supply and sanitation, free community health services and integrated urban renewal projects. Secondly, the fund aims to sponsor other tiers of government for programmes which meet RDP criteria.

The initial allocation to the RDP Fund made in the 1994/95 fiscal year was R2.5 billion. The RDP Fund is to be increased by the same amount each year to an annual allocation of R12.5 billion by the 1998/99 fiscal year.

The Department of Mineral and Energy Affairs (DMEA) was allocated a budget of R716 374 000 which forms roughly 0.2% of the total government expenditure account for the current fiscal year. It forms part of the 'economic services' functional classification of the national budget. Figure 2.13 gives a breakdown of this Department's estimated expenditure for the 1995/96 fiscal year.

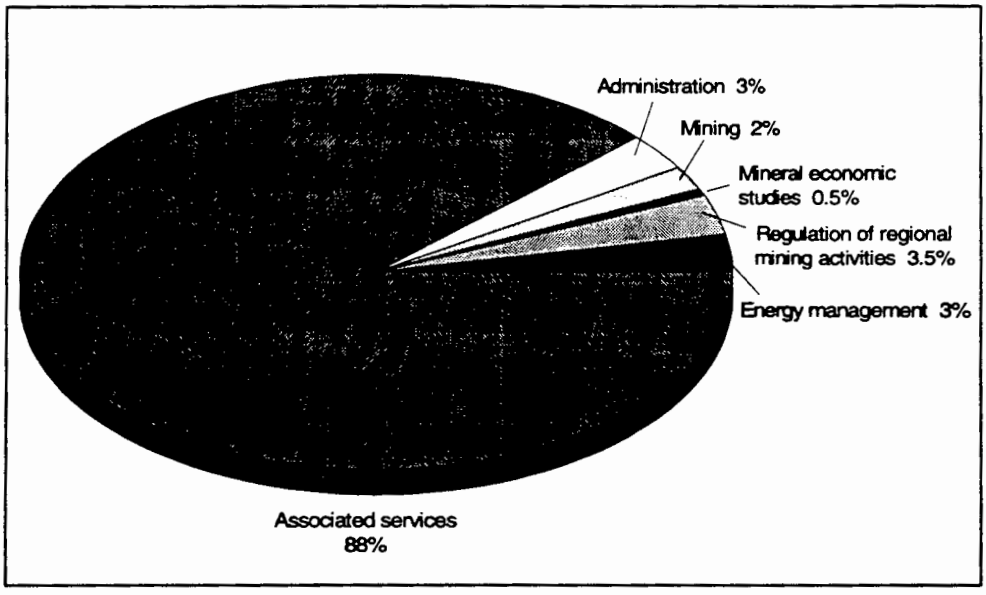


**Figure 2.13** Department of Mineral and Energy Affairs budget allocation - 1995/96
*(Source: Department of Finance 1995)*

The most noticeable feature about the DMEA's budget is its huge allocation to 'associated services' which is undefined in the public information available on budgetary allocations for the current fiscal year. The DMEA, however, confirmed that 68% of the 88% allocated to this category goes towards nuclear energy. It was further confirmed by this Department that, of the 68%, R311 million is a direct subsidy to the Atomic Energy Corporation (AEC). The AEC provides very little value added in return for its large subsidisation which has always been questionable. Van Horen (1994: 7) points out that

> it is highly questionable whether these huge accumulated investments in the AEC have delivered benefits which are justifiable from a national perspective. If the main motivation for the AEC's existence has been to support nuclear electricity generation, then its output has been singularly disappointing.

Only 3% of the DMEA's budget is allocated to energy management which refers to the Dpartment's research funding commitment to ensure the optimal utilisation of energy sources. Figure 2.14 depicts the breakdown of the department's expenditure on energy management, the largest share of which goes towards research on electricity and includes a budgetary allocation of 26.5% to energy for development.

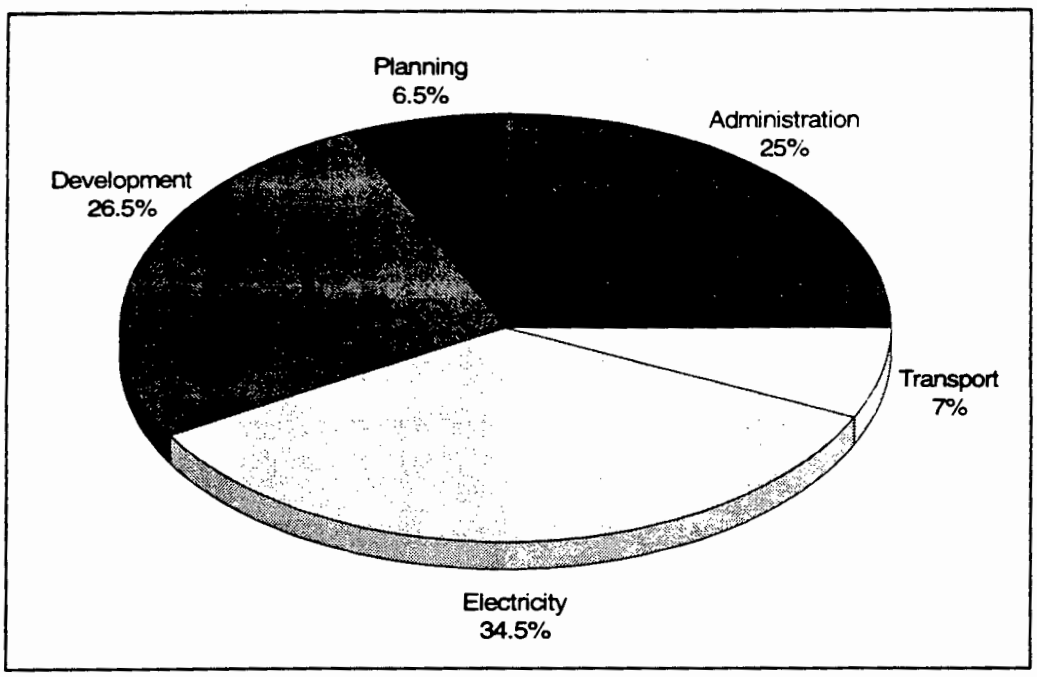


**Figure 2.14** Breakdown of DMEA energy expenditure for 1995/96
(Source : DMEA, 1995)

Figure 2.15 depicts the budget of the Department of Environmental Affairs and Tourism for 1995/96. This department's budget forms part of the 'economic services' functional classification of the national budget and is equivalent to just under 0.1% of the total government expenditure.

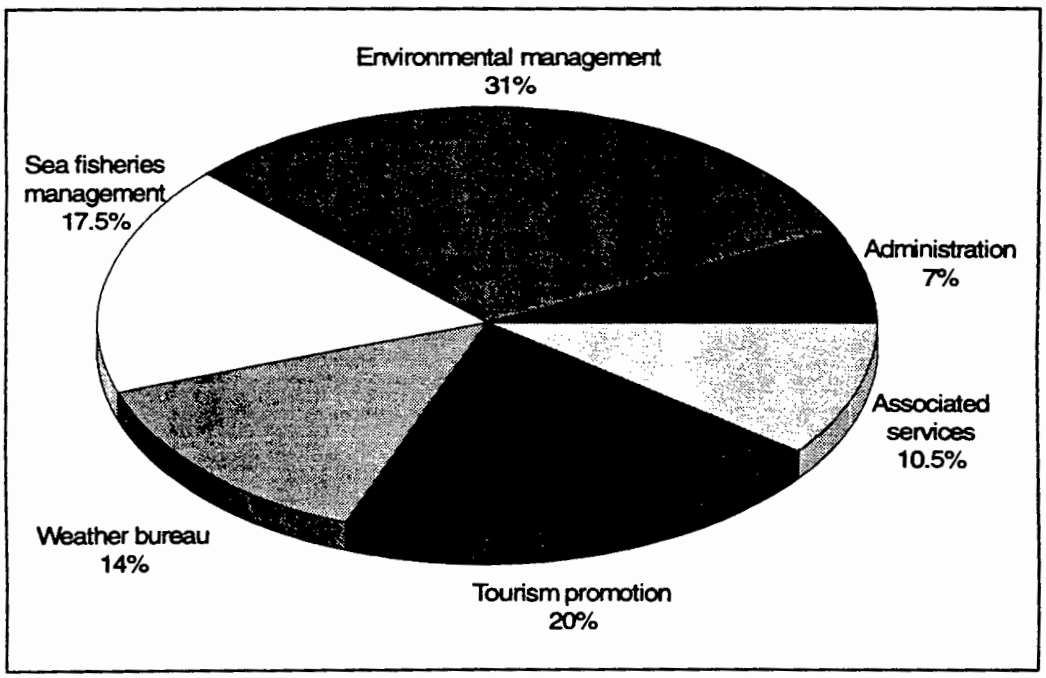


**Figure 2.15** Department of Environmental Affairs And Tourism budget allocation - 1995/96
*(Source : Department of Finance 1995)*

The largest share of this department's budget (31%) is allocated to environmental management which includes mainly nature conservation programmes of national parks and forests, waste management, pollution control and the management of hazardous waste in accordance with international standards (SAIRR 1995).

## 2.6. Stakeholders in the energy sector

The various stakeholders in the energy sector are listed in this section. A brief description of each is given.

- **The Department of Mineral and Energy affairs (DMEA)** develops energy policy. It also formulates energy legislation, administers regulatory control, funds energy research and controls the Central Energy Fund (CEF).
- **The Department of National Health and Population Development** in conjunction with its provincial and local counterparts, is responsible for administering South Africa's public health and air pollution control.
- **The Department of Environment Affairs and Tourism** administers the Environment Conservation Act No 73 of 1989 which provides for the management and protection of the natural environment.

  **The Department of Water Affairs and Forestry** is, inter alia, responsible for the provision of dams for hydro power stations and the protection of national indigenous forests.
- **Regulation of the petroleum industry**

  The **Central Energy Fund** is financed by levies on petroleum products and promotes the production of liquid fuels from local resources e.g. Mossgas and Soekor.

  The **Equalisation Fund** is also financed from levies on the sales of petroleum products and used to finance premiums on the procurement of oil, subsidies for Mossgas and Soekor, and equalisation of domestic fuel prices against short-term fluctuations in international oil prices.

  The **Strategic Fuel Fund Association** is a non-profit subsidiary of the CEF and was responsible for the purchase and stockpiling of fuel during the apartheid era.
- **Soekor** is a largely state funded corporation established to search for indigenous oil and gas reserves.
- **Sasol** operates an oil from coal plant and is involved in coal mining, coal conversion, oil refining, fuels marketing, chemicals, polymers, mining explosives and fertilisers.
- **Mossgas** was established by the CEF at a capital cost of R11 billion to undertake the production of petroleum products from natural gas off South Africa's Southern coast.
- **Eskom** is the national electricity utility which generates, distributes and supplies roughly 98% of the country's electricity. It owns and operates Africa's only nuclear power station in the Western Cape.
- **Local Government Electricity Distributors** are responsible for supplying (mainly residential) electricity generated by Eskom in their areas of jurisdiction. As of 1994, there were some 400 distributors.
- **The Atomic Energy Corporation** exercises control over uranium, its production and trade and operates a nuclear research centre which is mainly subsidised by government funding.
- **The Council for Nuclear Safety** forms part of DMEA and is responsible for the licensing of all nuclear installations and operations in South Africa to ensure that international safety standards are adhered to.
- **Research institutions** include the Energy and Development Research Centre (EDRC), the Energy Research Institute (ERI), the Mineral and Energy Policy Centre (MEPC) and other similar organisations.
- **The National Electricity Regulator** (formerly known as the Electricity Control Board) represents a wide spectrum of stakeholders and implements public policy for the electricity sector by issuing licenses for the distribution, transmission and generation of

electricity in South Africa. It has the power and mechanisms to determine conditions of supply and set tariffs.

- **Non-government Organisations** include environmental and energy groups. Examples include the Environmental Monitoring Group (EMG), green movements and so on.
- **The Women Energy Group (WEG)** is a lobby group comprising women academics, engineers and urban and rural community members who are attempting to ensure that women's needs and interests are reflected in policy making in the energy sector.
- **Labour unions** such as the Confederation of South African Trade Unions (COSATU), the National Union of Mineworkers (NUM) and the National Union of Mineworkers of South Africa (NUMSA) are key stakeholders in influencing policy on energy-related environmental issues.

CHAPTER THREE

# Energy-related environmental problems

Historically, energy policy in South Africa has not *explicitly* concerned itself in any significant way with environmental issues. Instead, it was left to entities within the energy sector to face problems without the benefit of a clear national policy to guide their actions. The `problems' therefore tended to be defined by those with political and economic power, namely policy-makers, suppliers and producers of energy services and products rather than by the majority of people whose daily lives revolved around making ends meet with limited resources.

Thus, public attention on energy-environment problems has centred around issues such as pollution in the Eastern Transvaal Highveld (ETH) where most of Eskom's coal-fired power stations are located (see, for example, Tyson et al 1988). At a smaller scale, but nevertheless receiving some attention, were issues such as the siting of high-voltage transmission lines. Whilst these issues may have been important in their specific contexts (and remain so), energy-environment problems have generally not been approached in a systematic manner, with due attention to their development contexts.

For the purpose of identifying and dealing with energy-environment problems in South Africa, this section follows a systematic approach which begins at the household level, moves up to the national and regional scales, and ends at the global scale. In each case, the nature of the problem is defined, the stakeholders involved are identified, government policies, programmes and projects are outlined, and the impact of certain actions related to the energy-environment problem is determined.

It is important to note that, because of the interim status of South Africa's government of national unity and its recent transformation to democratic rule, some national departments are still in the process of clarifying their roles and functions. The same can also be said for administrative responsibilities which cut across the different levels of government. The administration of the Atmospheric Pollution Prevention Act (No 45 of 1965), for example, was officially shifted from the national department of Health and Population Development to the department of Environment Affairs and Tourism. In practice, however, the Act is still being financed and administered by the former department (Van Horen et al, 1995 :39) and Part III of the Act is still enforced by the respective departments of health at local government level. It is therefore difficult to make assumptions about the relative strength and weaknesses or the degree of support likely to be afforded by various stakeholders to various proposals or policies placed on the country's national agenda.

## 3.1. Energy-environment problems at the household level

Almost two-thirds of the South African population did not have access to electricity in their homes in 1990 (Van Horen et al 1993: 624), with the result that they rely on wood, coal, paraffin, gas and candles to meet their energy needs. Recent research has found that serious environmental and health problems result from this pattern of energy use. Figure 3.1 indicates the percentage of domestic fuels utilised by urban and rural poor households in South Africa.

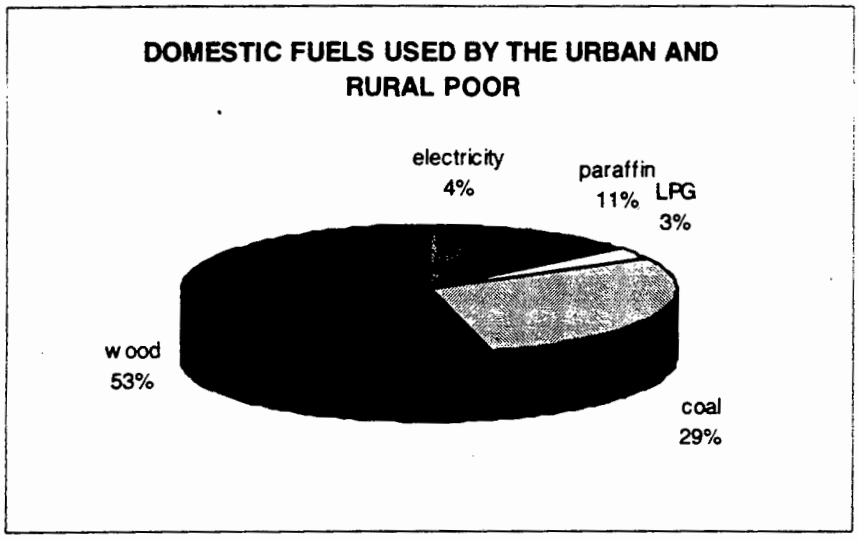


***Figure 3.1*** *Domestic fuels used by the urban and rural poor - 1990*
(Source : Trollip, 1994)

Six energy-related environmental problems at the household scale are identified. The nature of each of these problems is discussed in this section and, where possible, how it impacts on people, the economy and the environment. At the household scale, the impact of energy-related environmental problems is mainly directly experienced by people.

### 3.1.1 Poor air quality in urban coal-using areas

Air quality is severely degraded in urban coal-using areas. Approximately a million households, some of which are electrified, use coal to supply at least three of their energy service requirements: cooking, space heating and water heating.

#### *3.1.1.1 Nature and impact of the problem*

Pollution monitoring undertaken in several historically black residential areas by the CSIR and MRC has found that peoples' exposures to indoor air pollution, especially particulate matter, exceed US and WHO health standards by a factor of five to six during winter, and two to three during summer (Terblanche et al 1992: 15). As in China, where domestic coal consumption is also prevalent, adverse health effects result, such as respiratory infections like pneumonia, with exposed populations having double the usual incidence of respiratory infections (Terblanche et al 1992: 15). The potential seriousness of this problem in South Africa is underlined by the fact that respiratory infections are the second most common cause of infant mortality in the country (after diarrhea-related illnesses), with a mortality rate due to pneumonia among black South African children, about 270 times higher than the equivalent rate in Western European countries (Von Schirnding et al 1991: 79, 81).

#### *3.1.1.2 Stakeholders*

Coal companies producing coal for retail to households are important stakeholders as far as environmental responsibility is concerned. Other stakeholders operating at the household scale who are likely to be concerned with poor air quality in urban coal-using areas, apart from households themselves, include the Department of Mineral and Energy Affairs (DMEA), the respective health departments at national, provincial, metropolitan and local levels of government, as well as community-based organisations.

The DMEA is supportive of promoting low-smoke coal as a means of reducing high human exposure levels to pollutants from the use of bituminous coal. Its role is to facilitate and coordinate research in this field. The responsibility of administering national legislation on atmospheric pollution control rests with the Department of National Health and Population Development but has, theoretically, been shifted to the Department of Environmental Affairs and Tourism (Van Horen et al, 1995).

Provincial and national governments in South Africa are also respectively responsible for the operation and funding of provincial hospitals and localised day hospitals where the focus is on curative medical practices and research. This level of health service delivery together with efforts on the part of the DMEA, is best positioned to actively support programmes to address the problem of human exposure to pollutants from the use of coal.

The function of the health departments at the local and metropolitan levels of government is twofold. Firstly, they treat the symptoms of the problem of poor air quality in urban coal-using areas and not the causes. By this it is meant that they would treat cases of respiratory diseases resulting from exposure to pollutants from the use of coal. In the city of Johannesburg (the largest urban area in South Africa, and located in the province of Gauteng where the number of coal-using households is greatest) it is acknowledged that in 1992/93 'diseases of the circulatory system such as ischaemic heart disease as well as accidents, violence, cancer and diseases of the respiratory system continued to be the leading causes of death' (City of Johannesburg 1993). Secondly, it is their function to monitor air pollution in their respective areas of jurisdiction. This function is, however, limited to environmental pollution monitoring and prevention outside and not inside the dwellings of urban coal-users, even though national legislation permits them to monitor and control the air quality inside a dwelling as well. Health departments in metropolitan and local authorities are not necessarily unsupportive of addressing the problem of poor air quality in urban coal-using areas. The focus of their function is, however, on preventative medical practices concerned with notifiable diseases like tuberculosis, sexually transmitted diseases (aids, venereal disease) etc., as well as community health care (geriatric services, ante-and-neo-natal care etc.).

The African National Congress, South Africa's political party enjoying majority support, recognised that in Gauteng (formerly known as the PWV area) 'deaths from respiratory disorders among African children were up to 270 times higher on the Witswaterand than in Western Europe in 1994' (SAIRR, 1994/95 :35). As the author and director of the RDP, this national party and its provincial and local counterparts are likely to be active policy-brokers to address the problem concerned.

Community-based organisations in South Africa are emerging as organised local lobbyists to access RDP funds so as to address various economic, environmental and social problems experienced at the community level. While there is no evidence as yet from these groupings of active lobbying for addressing the problem in question, it can be said with certainty that they would support any positive moves towards this.

#### *3.1.1.3 Government policies, programmes and projects*

Part III of the Atmospheric Pollution Prevention Act (No 45 of 1965) provides for the control of smoke and is therefore relevant to the elimination of domestic use of coal and the adoption of low-smoke fuel alternatives. The power to enforce this section of the Act rests with local authorities who monitor emissions and enforce the regulations (Van Horen et al 1995: 41). The enforcement of this Act, through the declaration of smoke control zones, is described as inappropriate and difficult. It is inappropriate in that it has generally been applied in historically white local areas throughout the country where 'the dependence on and use of coal is less than for those people who can afford cleaner alternatives' (Van Horen et al 1995: 41). These households also have access to electricity. It is difficult to apply the provisions of the Act to coal-using or coal-dependent townships where residents cannot be expected to comply with regulations owing to their dependence on coal-based appliances and lack of access to alternative affordable energy sources. The Act can, however, provide the necessary support for policy interventions to address the problem in question.

The DMEA commissioned a study on the synthesis of low-smoke fuels so that key issues could be identified and considered in future research and intervention strategies (Dickson et al 1995). Support for research is therefore available. This Department also embarked on a low-smoke coal programme discussed further on in chapter 4 of this paper.

There is no indication of any special programmes proposed by the RDP, the Department of National Health and Population Development and its counterparts at lower tiers of government, to address the problem under discussion (Ministry of Health and Social Services

- Western Cape Province 1995). However, the Department of National Health and Population Development's budgetary allocation for the 1995/96 fiscal year makes provision for health protection against environmental problems emanating from the environment for which 3% was allocated of this Department's total budget allocation of R1 138 088 000. It is assumed that exposure to pollutants from coal usage is included in this category.

### 3.1.2 Poor indoor air quality among rural wood-using households

A second major energy-environment problem in the household sector, is the poor indoor air quality among rural wood-using households.

#### *3.1.2.1 Nature and impact of the problem*

In only one South African study has pollution monitoring of rural wood users been undertaken, and the results of this study found even higher particulate exposure levels than in urban coal-using homes. Children were found to have exposures to particulates over 12 hours, ranging from 1 044 $\mu gm^{-3}$ to 8 330 $\mu gm^{-3}$, with a mean of 2 367 $\mu gm^{-3}$ (Terblanche et al 1993: 56). By comparison, the US 24 hour standard is 260 $\mu gm^{-3}$, and the WHO lowest-observed-effect level is somewhat lower, at 180 $\mu gm^{-3}$. International epidemiological research has conclusively linked similar levels of pollution exposure to illness and death from respiratory disease, cardiac arrest and lung cancer (Lerer 1994a: 2). In South Africa, the majority of rural people use fuelwood without stoves or chimneys, suggesting that a large number of people may potentially be exposed to dangerously high pollution levels.

The environmental problems encountered by the urban and rural poor result in huge costs to the country and to the poor themselves, both in terms of direct costs incurred, for example, on health care, and in the foregone opportunities, such as early death, low productivity and time wasted in domestic tasks (Van Horen 1994).

#### *3.1.2.2 Stakeholders*

National, provincial and local authorities as well as rural community-based organisations constitute the major stakeholders concerned with the problem of rural wood-using households. The roles and functions of these stakeholders, in terms of addressing the problem from a medical health and air quality control point of view, are the same as those described under the section on poor air quality in urban coal-using areas. However, it is important to note the relative weakness of stakeholders representing the interests of rural households.

#### *3.1.2.3 Government policies, programmes and projects*

The Atmospheric Pollution Prevention Act (No. 45 of 1965) applies to rural areas in the same way as it does to urban areas. Furthermore, there are no special programmes or projects recorded to indicate the government's intention to address the problem directly and as a matter of priority.

### 3.1.3 Accidents with paraffin and candles: fires, burns and poisoning

The third category of energy-environment problems in the household sector results from accidents with paraffin and candles: fires, burns and poisoning.

#### *3.1.3.1 Nature and impact of the problem*

Data has not been collected on a sufficiently wide scale to provide an accurate assessment of the extent of these problems in South Africa; nonetheless, the data which does exist suggests that paraffin poisoning, injury and death from fires, and loss of property especially in informal settlements are serious problems. Paraffin poisoning is most common among children between one and three years of age in low-income areas, where paraffin is sold by informal traders in a variety of containers, including re-used drinking bottles, with the result that infants easily mistake paraffin for more palatable drinks (De Wet et al 1994). Household surveys in various parts of South Africa suggest that between 1% and 6% of poor urban households have experienced incidents of poisoning in the recent past (Van Horen 1994: 34). Less data exists on the incidence of fires and burns, although that which has been collected, suggests that such incidents are relatively frequent among low-income households and that

domestic accidents related to cooking or heating account for a sizeable portion of child deaths (Lerer 1994b: 169). Moreover, apart from the loss of life which often results, the direct economic costs of these problems may also be highly significant (Delport 1994: 2). Van Horen (1994) suggests a total of about 17 000 cases of paraffin poisoning per annum in South Africa: 'If only a quarter of these are hospitalised, at an average cost of R500 per treatment, then the total *direct cost* of health care expenditure on paraffin poisoning will be over R2 million per annum'.

#### *3.1.3.2 Stakeholders*

The stakeholders involved with the problem of accidents with paraffin and candles include the end-users themselves (mainly low-income households), suppliers and retailers of paraffin in the formal and informal economies, the Departments of National Health and Population Development and Mineral and Energy Affairs. A further category in the formal sector, known as routers, exists somewhere between suppliers and distributors. Oil companies constitute suppliers and producers of paraffin in the formal economy. Formal retailers and small traders operating spaza shops in the informal economy constitute the final retailing sector of the product. Routers are intermediaries who operate depots to which oil companies distribute their products and who, in turn, distribute to retailers. The role of the Departments of National Health and Population Development and the DMEA are respectively to provide medical treatment for victims of accidents resulting from the use of paraffin and candles and address the issue through regulation and intervention.

#### *3.1.3.3 Government policies, programmes and projects*

Oil companies are governed by the Liquid Fuel and Oil Act, No. 49 of 1947, the provisions of which regulate paraffin distribution and pricing. Williams (1994: 59) describes the paraffin pricing system in the following way:

> The depots are shared by the oil companies to minimise capital and administration costs. They represent the wholesale level, and are the last point at which paraffin prices are regulated by government. Included in the regulated price is the so-called service deferential ... intended to finance the distribution costs of paraffin from oil company depots to retailers.

The existing legislation also allows retailers a mark-up of 33.3% on the wholesale price which is fixed at a maximum allowable level by government. However, 'retail prices are not monitored at all and often far exceed the allowed price' (McGregor, 1993 cited in Williams, 1994). The final prices paid by end users are therefore exceptionally high.

Existing legislation governing the distribution of liquid paraffin makes no provision for the safety and/or prevention of accidents as a result of paraffin usage. The benefits of the legislation governing paraffin distribution and pricing to end-users and small informal retailers are therefore highly questionable. Existing national health regulations do not address the problem either.

Apart from complaints lodged to researchers (Annecke 1993) by dissatisfied end-users about the use of paraffin in their homes, there is no indication of any active attempts to address the problems associated therewith. End-users, especially women, preferred 'to use paraffin in the absence of anything better, and because they had so little money' (Williams, 1994 :56).

### 3.1.4 Fuelwood scarcity

Household fuelwood consumption in rural areas constitutes a fourth problem, namely fuelwood scarcity or deforestation.

#### *3.1.4.1 Nature and impact of problem*

Whilst it is over-simplistic and misleading to attribute 'deforestation' to the cutting of trees for firewood (Katerere 1992), the fact remains that fuelwood scarcity is increasing in many parts of South Africa, thereby placing additional demands on the time and energy of those responsible for its collection (usually women and children). Generalisations should be avoided regarding fuelwood scarcity in the country, since some areas such as those in the

wetter eastern regions have adequate supplies of fuelwood; on the other hand, however, it is clear that wood resources are being used at unsustainable rates in many rural areas. The concern in South Africa that fuelwood as a resource is becoming denuded is, nevertheless, serious for the natural environment. Land and soil erosion may result but the reasons for this are attributable not only to the cutting of trees for fuel; inappropriate agricultural practices and overgrazing by livestock also lead to land degradation (Van Horen 1994: 45).

The denudation of woodlands can also result in water flow patterns being altered with discharge rates being higher during heavy rainfall periods and the converse applying during dry periods. Furthermore, the fauna and flora may be adversely affected by the cutting of trees:

> Habitats of large animals may be degraded to the extent that they cannot survive at all.... The loss of habitats, especially in areas where heavy land-use causes total deforestation, represents an obvious threat to the diversity of biological systems. (Van Horen 1994: 46)

#### *3.1.4.2 Stakeholders*

Environmental matters in South Africa are mainly the responsibility of central government even though some responsibility rests with provincial and local authorities (SAIRR 1995). The national Departments of Forestry and of Environmental Affairs and Tourism are key stakeholders in addressing the issue of deforestation. Municipalities in small rural towns and departments of forestry in small rural areas established woodlots for fuelwood for rural communities in South Africa more than a century ago. These have over the years mostly been transferred to traditional authorities and the current condition of the woodlots is generally poor (Eberhard & Van Horen, 1995).

Wood users, especially women, are the most important stakeholders to be affected by fuelwood scarcity. Ironically, they can also be regarded as the 'producers' of the environmental problem, more out of necessity than choice. The recently established Women Energy Group (WEG) is likely to become a key stakeholder and representative of not only women energy end-users but other marginalised groupings as well. The relative weakness of this emerging group to influence decision-making at a national scale on the issue in question is acknowledged.

#### *3.1.4.3 Government policies, programmes and projects*

The Environment Conservation Act (No. 73 of 1989) provides the basic framework for governing environmental legislation in South Africa and potentially harmful activities to the environment (SAIRR, 1995). Van Horen (1995: 82) states that generally very little legislation governing woodlot development and the use of natural wood resources exists in South Africa.

### 3.1.5 Low-income household energy efficiency

A fifth area on which increasing attention is being focused at the household scale in South Africa, is energy efficiency in low-income households.

#### *3.1.5.1 Nature and impact of the problem*

The urban poor in South Africa reside mainly on the city's edge, typified by an urban fabric which is mostly unacceptable in terms of basic human comfort. The term 'urban fabric' defines the environment in which household dwelling structures are located, for example, informal urban settlements or shack developments. The dwelling structures inhabited by this sector are built without adequate insulation or with no insulation at all and therefore expose the occupants to hot and cold temperature extremes and inefficient and costly space heating especially in the cold, rainy winter season (Sellick 1993: 2). Where there is no access to electricity in areas of this nature, the most common fuels used for space heating purposes are wood, coal and paraffin, which account for a significant proportion of household income in this sector (Williams 1994).

The typical South African city's apartheid history which prevented, through Group Areas and other legislation, the location of the urban poor close to urban opportunities, intensified

the marginalisation of this sector. A direct consequence of this marginalisation is that the poor often find themselves in spaces on the city's periphery which would under more equitable circumstances have been declared unsuitable for urban development unless appropriate intervention, like land fill, was commissioned to make these suitable. Informal urban settlements are often located on wetlands or land with high water tables and inadequate drainage services to overcome such problems. This, together with wind leaks and damp penetration, increases the need for space heating.

The economic disadvantage of locations away from urban opportunities and services like electricity necessitates a trade-off between access and pricing. This hinders efficiency because people are obliged to pay dearly for energy services and sources from the informal economy which is expensive. These services would otherwise be more easily accessible and cheaper to obtain within the formal urban economy.

The imperative to address thermal performance of dwellings and related concerns such as appliance efficiencies also becomes apparent when the impact of household electricity consumption on the national electricity system is observed. While domestic consumers account for only about 14.6% (Eskom 1994a: 41) of total electricity consumption, their impact on the system is disproportionately large because of their poor load profile. This became increasingly evident following the commencement of electrification efforts several years ago.

Figure 2.11 indicates that in 1992 on the day of peak demand, domestic consumption caused the system peak to shift from the conventional mid-day peak coinciding with industrial and commercial consumption, to an evening peak coinciding with the use of household appliances (Van Horen et al 1993: 635). Clearly, in the context of an electrification programme which will increase the number of domestic consumers from the current 3.5 million to about 6 million in five years, it is critical that energy efficiency and conservation strategies are developed as a matter of urgency.

#### *3.1.5.2 Stakeholders*

The stakeholders involved in energy efficiency at the household scale include, apart from the households themselves, Eskom as the national generator and largest distributor of electricity, local authorities as distributors, the DMEA as funders of research projects, oil and coal companies, mortgage lenders and builders. Stakeholders on the supply-side (Eskom, local authorities, etc.) have a greater responsibility towards reducing the environmental impact of fuel production. The introduction of energy efficiency measures on the demand-side can be seen as an energy-saving tool for the household and therefore more environmentally sustainable.

#### *3.1.5.3 Government policies, programmes and projects*

The Electricity Act of 1987 and Eskom Act of 1987 are the main pieces of legislation governing electricity generation and distribution in South Africa. Energy efficiency is not mentioned at all in either of these governing measures. While current national building regulations have minimum standards for the construction of housing, thermal efficiency is not an explicitly stated objective of these regulations. The government's RDP regards thermal efficiency as important.

The Department of Mineral and Energy Affairs' Energy for Development directorate supports research projects on energy efficiency to inform its policy making. It introduced a manual containing guidelines for Housing Boards which contain thermal comfort considerations.

Eskom's Residential Demand-Side Management Programme includes the improvement of the thermal performance of low-income dwelling structures. Its motivation for this is to reduce the domestic load profile during peak demand.

Eskom's five-year research funding commitment of R238 million between the years 1994 and 1998 includes an allocation of R2 million (2.2%) to energy management systems where the focus is on energy efficiency and conservation (Eskom 1993). In the current year (1995) an amount of R630 000 has been allocated to the thermal performance of dwellings and adequate and affordable energy services for the urban poor (Eskom TRI 1995).

Local authorities in South Africa pay very little attention, if any, to the thermal performance of the housing schemes they develop and administer.

Builders, mortgage lenders, oil and coal companies are not legally obliged to promote energy efficiency and there are no incentives from government to encourage this. The National Housing Forum supports the concept of sustainable solutions to the housing the poor. Thermal efficiency is recognised as an integral part of this (Thorne 1995).

### 3.1.6 Transportation efficiency at the urban household scale

A final energy-environment problem closely associated with energy efficiency is that of inadequate access to efficient and affordable public transportation at the household scale.

#### *3.1.6.1 Nature and impact of problem*

The structure and form of the South African city is not very conducive to efficient travelling and commuting (Boerne & Hatfield 1994), especially for the urban poor household sector who most often reside on the urban periphery and away from higher order urban opportunities like places of work, hospitals, tertiary educational institutions and so on. City structure is oriented to accommodate mainly road transportation and especially the private motor-car which in itself presents problems like those of congestion and pollution. Public transportation in South African cities is generally inadequate.

The private motor vehicle is not a very affordable commodity given its high entry-and-operating costs. A study conducted in Khayelitsha, a township in the Cape Town metropolitan area, revealed that a sample of this community that has access to electricity used about the same amount of household income on energy services (including hire purchase of appliances) as on transport (Thorne & Theron 1993). This raises key economic questions around the ability of urban poor households to afford easy and convenient forms of transportation. Household energy needs and demand should therefore take into account access to public transportation requirements as well.

> The primary physical barrier to ease of access is the cost of overcoming the friction of distance.... The degree to which urban living is dependent upon the car defines the degree to which the poor are spatially marginalised and materially impoverished by city form. The technology of movement, therefore, must be accessible to all. (Dewar & Uytenbogaardt, 1991: 17).

The environmental impacts of inefficient transportation in the country is discussed in the section on transportation at the national scale.

#### *3.1.6.2 Stakeholders*

The national and provincial Departments of Roads, Transport and Public Works, the Metropolitan Transport Planning authorities and local governments as well as private transportation companies providing commuter services and commuters themselves are the key stakeholders involved in addressing the issue of transportation efficiency at the household scale.

#### *3.1.6.3 Government policies, programmes and projects*

Transportation policies, programmes and projects will be discussed in the section on transportation at the national scale. It is, however, important to point out that the city of Cape Town is contending to host the 2004 Olympic Games. This major event would have far-reaching economic and environmental implications for the city and the country. It is estimated that R470 million is to be made available for public transportation here should the city's bid be successful (Cape Town Olympic Bid Committee 1995). This provides a tremendous opportunity for Cape Town to restructure its city through a developmental approach to the planning and provision of public transportation. In this way, access by the marginalised to the opportunities of urban living could be improved and the dependence on private motorised transport, reduced.

## 3.2. Energy-environment problems at the national scale

A different range of problems arises at the national level. In the first place, the energy mix in South Africa and its neighbouring countries is dominated by non-renewable resources, principally coal. Of South Africa's primary energy, over 80% is supplied by coal and, of its electricity, 94% is generated by coal-fired power stations and almost all of the remainder by the region's only nuclear power station at Koeberg (Van Horen et al 1993: 623: Eskom 1994b: 64). The dominance of coal has numerous economic and environmental impacts. On the one hand, the abundance of coal reserves close to the surface has been a primary reason for historically cheap electricity supplies in South Africa. In 1994, Eskom reported that its bulk prices were the second lowest in the world after New Zealand's (Eskom 1994b: 7) and, in 1995, that it was the cheapest of all. Cheap electricity has been presented as an important comparative advantage for the country, especially as an incentive to international investors seeking sites for energy-intensive industries. In the words of an Eskom executive, `access to reliable and internationally competitive electricity should entice investment in electricity intensive activities to South Africa and enable it to potentially become the "electricity valley" of the world, analogous to a "silicon valley" in the USA' (Van Pletsen 1994: 4).

### 3.2.1 Pollution from coal

This section is concerned with atmospheric pollution in the Eastern Transvaal Highveld (ETH) where a high concentration of industrial and mining activities occur.

#### *3.2.1.1 Nature and impact of the problem*

Research carried out in the 1980s in the Eastern Transvaal Highveld (ETH) where most of Eskom's coal-powered stations are located, found that pollution levels, especially of sulphur dioxide, were frequently above environmental standards (Tyson et al 1988). At the time, it was suggested that acid precipitation and other atmospheric pollution were potentially serious problems. In subsequent years, Eskom's own monitoring programme has suggested that pollution levels in the ETH have been constant or in some cases, even declining (Turner 1990). The issue of ETH air pollution is a contentious one, with conflicting views among scientific, industrial and environmental groups. The RDP regional document drawn up for the Gauteng (former PWV) region, recognises that electricity 'produced at coal-fired power stations in the Eastern Transvaal, caused pollution, including acid rain which damaged crops and indigenous flora' (SAIRR 1995). Climatic conditions in the ETH are not favourable for the dispersion of air pollution emitted close to ground level. In fact, they were rated in a study by Tyson et al, as 'among the most unfavourable anywhere in the world' (1988: 1). With Eskom's current over-capacity appearing as if it may be utilised sooner than expected, decisions will have to be made in the near future about bulk investment options. An essential issue in these decisions is that of the environmental impacts of the various options which are available: further coal-power, or gas, nuclear, hydro from the region or efficiency improvements. A further consideration is the impact South Africa's coal-fired electricity production has on neighbouring countries.

#### *3.2.1.2 Stakeholders*

The two national Departments of National Health and Population Development and Environmental Affairs and Tourism as well as Eskom, coal companies and environmental groups are the major stakeholders concerned with the issue of pollution from coal for electricity generation.

#### *3.2.1.3 Government policies, programmes and projects*

The provisions of the Atmospheric Pollution Prevention Act (No. 45 of 1965) (theoretically) administered by both national departments govern four types of pollution: noxious gases, smoke, dust and vehicle emissions. In theory, the Act provides for the uniform treatment of all forms of air pollution. There are no specific provisions for the control of sulphur emissions.

The management approach to industrial pollution is based on 'best practicable means', an approach which is not only lenient but allows for the subjective evaluation of the environmental impact of air pollution from (electricity from) coal, the interpretation of which

is done by the administering authority in collaboration with the industries concerned. In accordance with this management approach, the Department of National Health and Population Development has issued a set of guidelines for pollution concentrations. The Act does not contain any standards for pollution levels in ambient air, such as those applied by the USA Environmental Protection Agency, which are legally binding (Van Horen 1994).

It was stated earlier that the department of Environmental Affairs and Tourism allocated 31% of its budget for 1995/96 to environmental management which includes research on pollution control.

As a major industrial manager, Eskom has a pollution control philosophy with two main foci. Firstly, environmental interventions by Eskom are directed at 'controlling particulate matter as a first priority with the control of sulphur dioxide and nitrogen oxide emissions only of secondary concern'. Secondly, Eskom's environmental policy is aimed at 'those gases which are not removed at any stage in the electricity generation process. This involves the use of tall chimney stacks to achieve maximum dispersion of pollutants into the upper atmosphere' (Van Horen 1994: 9).

### 3.2.2 Environmental externalities and electricity prices

Cheap electricity is indeed an advantage for South Africa and potentially the region, especially in the light of current efforts to widen access to electricity to low-income households. However, concern exists that electricity prices do not adequately account for *environmental externalities*, and that the signals which low prices present to consumers may cause resources to be misallocated.

#### *3.2.2.1 Nature and impact of the problem*

Low energy prices have had a further structural effect on the South African economy and environment in that there has been little or no incentive among industrial and commercial consumers to use energy efficiently. If anything, the incentive has been the opposite, with the result that the economy is highly energy-intensive. It was indicated earlier in Figure 2.7 that industry and commerce together account for almost half of the country's energy consumption. It was also stated earlier that over 80% of South Africa's primary energy is supplied by coal. The impact of coal combustion on the atmosphere in the ETH has been discussed above. International experience suggests that potential gains from energy efficiency and conservation measures could be significant, yet this potential remains largely untapped in South African industry.

According to Bredell and Louw (1991: 4), it has been estimated that about 1.6% of the total surface area in the ETH will be strip-mined in the long term. The authors report further that rehabilitation of this land can restore most of it to a condition in which agriculture can achieve reasonable yields. Reclamation and rehabilitation occur at enormous cost, and in the intervening period, the local environment suffers significant damage (El-Hinnawi 1981: 14).

Coal-mining has serious impacts on the health and safety of mine-workers. Not only are workers exposed to high levels of coal dust but they are also prone to high risks of injury or death from accidents. The low price of coal does not account for ongoing occupational health and other hazards from coal mining. Coal-mining is also known to have detrimental impacts on water quality because of the high levels of, among other factors, total dissolved salts (TDS) which penetrate underground and surface water supplies, causing the salinity of the water to increase (CSRI 1991: 71).

Further environmental problems arise during the processing and beneficiation of coal. Van Horen (1994) notes that South African coal has a high ash content which increases as the higher grade bituminous coal is mined out. 'The effects of this are threefold: larger volumes of coal are needed to meet particular energy requirements; secondly, more ash is produced during combustion, and thirdly, more discards are generated during beneficiation' (Bredell & Louw 1991: 5-6).

During South Africa's apartheid years when its quest for energy self-sufficiency was vigorously pursued in the face of international opposition to its apartheid policy, the state-

assisted oil-from-coal process was initiated by Sasol in the 1950s to substitute for oil imports. The additional coal consumed during this period, the incremental costs of processed liquid fuels produced at a cost higher than imported fuel, and the consequent environmental impacts, represent enormous costs to the South African economy. Of these, the financial costs have been largely borne by the national tax base and the environmental costs by communities living close to these industries (Van Horen 1994: 14).

Mentioned earlier is the Mossgas project which was established in 1987 to undertake the production of petroleum products from natural gas off the south-west coast, near the town of Mossel Bay. This undertaking was established for much the same political reasons of self-sufficiency as for Sasol. No consideration was given at the time to the environmental externalities which accompanied a large investment of this nature.

#### *3.2.2.2 Stakeholders*

Oil and coal companies, the two national Departments of National Health and Population Development and Environmental Affairs and Tourism, environmental groups, labour unions, research institutions and communities residing close to coal-producing areas, are the major stakeholders in this category of energy related environmental problems.

#### *3.2.2.3 Government policies, programmes and projects*

Other than the limited provisions of the Environment Conservation Act (No. 73 of 1989), the Atmospheric Pollution Prevention Act (No. 45 of 1965) and physical planning and land use legislation governing the location of hazardous industries, there are no specific proposals by government to address the environmental externalities discussed above.

The Department of Environment Affairs and Tourism initiated discussion in 1994 on various economic instruments available for the management of environmental resources in South Africa (Department of Environment Affairs and Tourism 1994). This discussion included the issue of externalities related to electricity generation and prices. It is therefore assumed that this department is preparing policy on environmental resource management and externalities.

The Petroleum Products Act (No 120 of 1977) determines the responsibility of the State in respect of the acquisition, manufacture, price determination and distribution of liquid fuels. The petroleum sector has a complex set of regulatory arrangements, which revolve mainly around the protection of the strategic investments in Sasol and Mossgas mentioned above.

The President's Council report recommended that integrated environmental management (IEM) become legally enforceable and that environmental impact assessments (EIAs) be prepared for any activity identified by the then Minister of Environment Affairs (1991). IEM is not known to have been implemented in energy-related industrial activity to date. The location of a steel plant at Saldahna Bay in the Cape where coal furnaces are likely to be used, has recently been required to undergo an environmental impact assessment by the Cape's provincial authorities.

### 3.2.3 Long-term disposal and storage of high-level nuclear wastes

At the national level, the ongoing question about long-term disposal and storage of high-level nuclear wastes, remains unresolved. With the nuclear industry recently being exposed to public debate for the first time, and with calls having been made for an independent economic investigation into the viability of the industry, it is essential that environmental costs be incorporated into such an investigation.

#### *3.2.3.1 Nature and impact of the problem*

Figure 2.6 above indicated that nuclear energy represents 2% of primary energy consumption in South Africa. It contributes about 6% of the total electricity generated by Eskom (Eskom 1991). The continued insistence on the generation of nuclear power has been a subject of ongoing debate in South Africa from an economic, political and environmental point of view. Electricity generated by the Koeberg nuclear power station is significantly more expensive than that derived from coal and therefore requires ongoing subsidisation from electricity consumers. It was also mentioned earlier that, as was the case for over twenty years, the

greatest share (68%) of the DMEA's 1995/96 budget is allocated to the nuclear industry and, of this, a significant amount is allocated as a subsidy to the Atomic Energy Corporation. It is suspected that the reason for this was to develop the country's nuclear armament capacity (Auf der Heyde et al 1987). This suspicion was confirmed by the South African government's admission in 1993 that it had in fact manufactured a number of nuclear weapons.

From an environmental point of view, 'the storage and disposal of high level wastes and the costs of decommissioning the nuclear facilities at the end of their useful lives', remain unresolved (MacKerron 1989). It is, however, also argued that nuclear energy is a cleaner option than fossil fuels and emits significantly less carbon dioxide than coal-fired power stations (Stumpf & King 1993; Pasztor 1991).

There are further concerns with nuclear power operations which have not been quantified in economic and financial terms. These include factors such as the risks of nuclear contamination in the event of an accident either at the nuclear facility itself or in the transport or storage of nuclear waste. A further factor to be considered is that of the risk posed to workers caused by routine and accidental exposure to radioactivity at various stages of the nuclear chain from the mining of uranium to the disposal of long-life waste (Gandar 1991: 102).

#### *3.2.3.2 Stakeholders*

The DMEA, Eskom, labour unions, research institutions, the Atomic Energy Corporation and environmental groups constitute the key stakeholders in the debate on nuclear power in South Africa.

It is clear that the DMEA remains supportive of the continued investment in nuclear energy investigations through its financial commitments to this sector. Eskom's argument to support nuclear power generation is based on the fact that nuclear energy is cleaner than fossil fuels as supply options for electricity. In this way, Eskom can contribute to avoiding global warming effects. This argument is not universally sustained, however, since there are cheaper and quicker demand side measures such as improvements in energy efficiency available to reduce carbon dioxide emissions (Pasztor 1991).

Criticisms of the nuclear industry recorded in sound research work by authors like Auf der Heyde et al (1987), and others mentioned earlier, are supported by non-government environmental groups who actively oppose the continuation of this industry.

#### *3.2.3.3 Government policies, programmes and projects*

The Nuclear Energy Act (No. 131 of 1993) provides for all nuclear activities funded by the state to be controlled by the Atomic Energy Corporation. The Council for Nuclear Safety is an independent body falling under the Minister of Mineral and Energy Affairs. It is the task of this Council to license all nuclear installations and operations in South Africa to ensure that international safety standards are adhered to (Eberhard & Trollip 1994: 11). Other than the application of international safety standards on nuclear installations, there is no legislation specifically addressing the problems highlighted above.

### 3.2.4 Transportation efficiency

The inefficient use of transportation in South Africa, together with the space-extensive nature of the country's urban structure and form discussed earlier under the household scale, impact on the environment in various and serious ways at the national scale.

#### *3.2.4.1 Nature and impact of the problem*

Figure 2.7 above indicated that 24% of South Africa's net energy consumption is used by the transport sector, the second highest consumer after industry and commerce. Boerne & Hatfield (1994) suggest that road transportation in South Africa is the largest user of energy, using 85% of energy in the form of petroleum and diesel.

The use of oil and combustion of diesel and petrol in motorised road transportation are major contributors to carbon monoxide, carbon dioxide, nitrous oxides, sulphur dioxide and lead emissions into the atmosphere thereby impacting negatively on air quality. The effects of pollution from motor vehicles come in the form of photochemical smog, a compound formed

by the action of ultra-violet radiation on industrial and vehicular emissions, especially nitrogen oxides and hydrocarbons (Bailie et al 1992). High levels of solar insolation, stable climatic conditions and relatively high vehicle densities in urban centres together result in frequent incidences of photochemical smog (Bailie et al 1992; Dutkiewicz 1989).

Pollutants from motor vehicles also have adverse effects on human health. A study on Woodstock, an inner city area in Cape Town, in 1983/84 revealed that atmospheric levels of lead were close to, and in some cases, exceeded the US EPA standard. Traffic density and meteorological factors were the main reasons for this (Von Schirnding & Fuggle 1984). Human health is further affected by exposure to traffic exhaust fumes which result in elevated blood levels (Grobler at al 1984). Excessive exposure to lead can also lead to immediate poisoning which can affect the central nervous and other systems (Disler et al 1984).

A key aspect of the inadequate provision of road and rail public transportation in South Africa's urban areas, is the proliferation of the petrol-driven combi taxi as a substitute. 'The trend throughout the world is for diesel engines in most public transport and commercial vehicles. This compares with South Africa where 100% of private taxis are still petrol powered' (*Engineering News* 1995).

The relationship between urban and rural areas is likely to improve in terms of economic, agricultural and employment exchange now that freedom of movement is less restrictive. Rural road infrastructure is in place to accommodate this linkage. Also, road and rail linkages are likely to improve between and among southern African countries with increased trade, tourism and other forms of regional cooperation.

Inter-regional road and rail linkages and the concomitant increase in the use of road transportation are likely to add to the problems of congestion and pollution in urban centres. These problems will be exacerbated by regional cooperation and trade in other economic sectors and linkages for example, the expected increase in the number of tourists to the region. The number of foreign tourists to South Africa, including visitors from other African countries, is estimated to be 4.5 million in 1995 and 9 million in the year 2000 (SAIRR, 1995: 60). The number of arrivals in South Africa from other African countries in 1993 and 1994 were respectively 2 142 249 and 2 462 277 (SAIRR, 1995: 60). The demand for road transportation will increase during peak tourist periods and will impact mainly on large urban nodes or centres which are thoroughfares to main tourist attractions in major cities in the region, like Johannesburg in South Africa, where goods and services are available. The environmental impact of increased motorised transportation in urban centres must be considered at the outset of the preparation phase of accommodating this increase.

#### *3.2.4.2 Stakeholders*

The national Departments of Mineral and Energy Affairs, Environment Affairs and Tourism, Health and Population Development and Roads, Transport and Public Works as well as their provincial and local counterparts are the main government stakeholders involved in this area. Non-government environment and research groups are also key stakeholders. One other key stakeholder is the South African Black Taxi Association. The energy and transport sectors as well as energy research institutions are key stakeholders in addressing land transportation efficiency in South Africa.

#### *3.2.4.3 Government policies, programmes and projects*

A joint working group, known as the Vehicle Emissions Working Group, has been established by the national departments of Health and Population Development, Mineral and Energy Affairs and Environment Affairs and Tourism to determine the contribution of vehicle emissions to air pollution in the major cities. The first report of this working group is to be completed at the end of 1995 (City of Cape Town, Medical Officer of Health's Annual Report 1993/1994). This information will be utilised by this Working Group to recommend policy interventions by government to reduce the impact of emissions on air quality from the use of motorised road transportation.

Unleaded fuel is considered as an option to address the issue of emissions from vehicular transportation in urban centres (Department of Mineral and Energy Affairs 1995; Department of Environment Affairs and Tourism 1994).

The Ministry of Transport is currently involved in debates about fueling South Africa's taxis with diesel instead of petrol. One of the reasons for this is that modern diesel engines are believed to be far less polluting to the environment than standard petrol engines. 'In comparison, diesel engines emit a fraction of the harmful invisible exhaust gases – Nox, hydrocarbon and carbon monoxide. They give out 30% less carbon dioxide'. Less harmful particulate emissions can also be reduced significantly with improved diesel engine combustion (*Engineering News* 1995).

There are no specific regional government treaties and policies related to the rehabilitation and/ or new construction of road infrastructure in the region which take account of the environmental impact on urban centres as a result of increased inter-regional transportation linkages. There is, however, an opportunity to pre-empt these environmental problems since the road/rail infrastructure is yet to be constructed and/or rehabilitated.

South African engineering and construction firms have secured major projects in other African countries like Zaire and Malawi where the World Bank is sponsoring a R10 million road rehabilitation project. Angola has been granted USD800 million by the World Bank for massive road and rail reconstruction. Part of this Angola's railway reconstruction is linked to the supply of rolling stock from South Africa to the value of R14 million (Davies et al 1993: 10).

## 3.3. Energy-environment problems at the regional scale

The success of addressing energy-environment problems at the regional scale is largely dependent on the degree to which countries in the region are willing to cooperate and share their energy resources in the most efficient way.

### 3.3.1 Coordinating regional energy resources

The Southern African economy has been dominated for the past two decades or more, by the destabilising effects of apartheid, and by the attempts of frontline states to improve their energy security. The political environment was therefore highly unconducive for collaborative ventures which could use the region's energy resources more effectively.

#### *3.3.1.1 Nature and impact of the problem*

The installation of the Government of National Unity and South Africa's subsequent admission to the Southern African Development Community (SADC), has transformed the political environment to a much more favourable one for regional ventures and cooperation, especially in the energy sector. The economics and politics of regional energy projects are important and complex issues which require the attention of policy-makers and other stakeholders. In addition to these more obvious factors, however, the environmental trade-offs of these projects also require careful consideration. 'Although South Africa has abundant coal reserves, regional hydropower projects would have the advantage both of supplying cheaper power and reducing the environmental pollution and acid rain associated with South Africa's coal fired stations' (Davies et al 1993: 8). Pollution knows no boundaries and already it is contended that southern Mozambique is being affected by pollution from coal mining activity in the ETH owing to prevailing winds and climatic conditions (SAIRR 1995). The extent of such impact on the Mozambican environment is not known.

The effects of shifting the region's energy mix from a fossil-fuel base in the South, to a hydro-electricity base in the North, may lead to a net reduction in environmental impacts, at lower economic cost, although the nature of environmental and social impacts will be qualitatively different and will be transferred to those areas in which new projects are developed. The equity implications of this transfer, given the relatively higher level of welfare in the South, may also present difficult problems for policy-makers seeking to achieve a more equitable form of regional development.

#### *3.3.1.2 Stakeholders*

Key stakeholders include Eskom, the respective departments and ministries responsible for the administration and management of energy in SADC member countries, SADC Technical and Administrative Unit (TAU), Southern African Development through Electricity (SADELEC), research organisations and international funding agencies. The activities of SADC TAU have thus far concentrated on six main sub-sectors: woodfuel, petroleum, electricity, coal, energy conservation and new and renewable sources of energy. SADELEC is an independent non-profit, non governmental regional organisation established in 1994.

It is essential that stakeholders give explicit attention to environment and equity considerations in addition to the more obvious economic, political and institutional issues, in developing regional energy projects. Failure to do so in the initial stages may lead to unnecessarily higher economic and environmental costs in the future, with fewer options for dealing effectively with them.

#### *3.3.1.3 Government policies, programmes and projects*

Trade in electrical energy is at present largely one way. In 1991 Eskom supplied power worth R155.5 million to six SADC member countries, while importing only R11.3 million worth from one, namely Namibia (Davies et al 1993). The dependence of SADC countries on South Africa for electrical power supply increased during the 1992 drought. For example, Zimbabwe's shortfall of 40-50 megawatts power due to the drop in the level of the Zambezi which decreased its hydroelectric power generation capacity, was partly supplemented by power imported from South Africa (Davies et al 1993). The former Chief Executive of Eskom, Dr Ian Mcrae, indicated in 1992 that his organisation is willing to advocate the establishment of a regional electricity grid to make feasible the possibilities of power sharing through various hydro-power projects. This grid would take the form of a transmission system linking a number of primary generation projects and consumers in the region. Eskom indicated to neighbouring countries its willingness to import between 10 and 15% of the country's total power requirements in the year 2000, an amount roughly equivalent to 3.000 to 4.500 megawatts (Davies et al, 1993).

Arrangements to increase regional cooperation in the energy sector would require the establishment of a multi-lateral power authority and tariff setting agency. To date, this authority has not yet been established.

## 3.4. Energy-environment problems at the global scale

One of the effects of the political isolation of South Africa up to 1994 has been that few resources were directed towards the issue of climate change, which has become so significant internationally in recent years. As a result, the country's policy-makers have had to catch up on much lost ground, both in terms of the international political processes surrounding the issue of global change, and the substantive implications of such change for the country in general and the energy sector specifically. Other countries in the region, such as Zimbabwe, are much further down the road than South Africa, and have already made several submissions required of them by the FCCC: for example, GHG inventory and abatement studies. This is an area in which South Africa stands to benefit from cooperation with its neighbours which have been involved in climate change debates and analysis for some years already.

### 3.4.1 South Africa's contribution to greenhouse gas emissions

The country's contribution to emissions of greenhouse gases (GHGs) is small on a global scale although this masks the fact that emissions are well above average on a per capita basis (Lennon 1992). This is primarily a result of the high level of coal use in the economy, not only for the generation of electricity, but also for the production of a large proportion of the country's petroleum products by Sasol's synthetic fuel operations. Other factors, such as those already discussed, related to the low energy prices and energy-intensive economy, reinforce the country's position as a relatively high emitter of GHGs.

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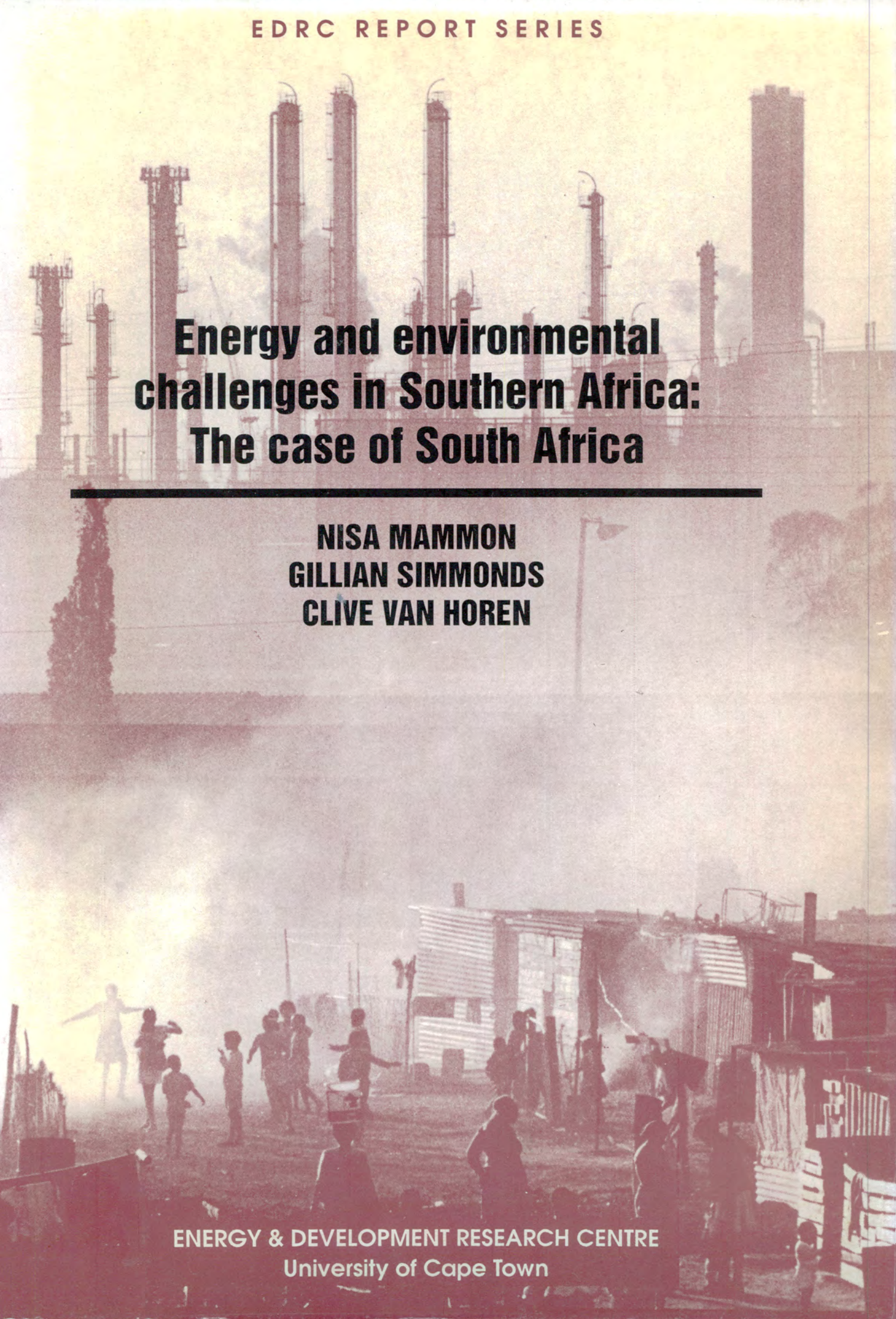

# Energy and environmental challenges in Southern Africa: The case of South Africa

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