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## Minerals, energy and geology

The Department of Minerals and Energy is the primary government institution responsible for formulating and implementing minerals and energy policy to ensure optimal use of these resources. It reports to and advises the Minister of Minerals and Energy who, in consultation with the Cabinet, takes final responsibility for policy.

Within the Department, the Electricity and Nuclear Branch is responsible for electricity and nuclear-energy affairs; while the Hydro Carbons and Energy Planning Branch is responsible for coal, gas, liquid fuels, energy efficiency, renewable energy and energy planning, including the energy database.

The objective of the Mineral Development Branch is to transform the minerals and mining industry and promote the sustainable development of the industry for the benefit of all South Africans.

The Mine Health and Safety Inspectorate (MHSI) is responsible for the application of mine health and safety legislation.

### Policy

The Minerals and Petroleum Resources Development Act (MPRDA), 2002 (Act 28 of 2002), was promulgated in May 2004. The Act recognises the



State's sovereignty and custodianship over the country's mineral resources; and provides for equitable access to mineral resources; opportunities for historically disadvantaged individuals (HDIs); economic growth; employment and socio-economic welfare; and security of tenure. Meaningful and substantial participation of HDIs in the mining sector is guided by principles contained in the Broad-Based Socio Economic Empowerment Charter. A scorecard for the Charter has been introduced to facilitate the application of the Charter in terms of the requirements of the MPRDA, 2002 for the conversion of all the 'old-order rights' into new rights.

The provisions of the MPRDA, 2002 have necessitated the establishment of the National Mining

Promotion System (NMPS), which has been installed in the Department of Mineral and Energy's offices. This online System allows the Department to improve on mineral licensing administration, investment promotion and the registration of rights. It ensures accurate data-capturing to enable immediate access to information of spatial overlaps on existing mining or prospecting permits. The NMPS enables the Department to improve on turnaround time when processing applications and maintain the proper management and administration of mineral-related rights and permits.

The Mining Titles Registration Amendment Act, 2003 (Act 24 of 2003), was promulgated on 26 November 2003 and came into effect on the com-

mencement date of the MPRDA, 2002, on 1 May 2004. The purpose of the Amendment Act is to re-regulate the registration of mineral and petroleum titles and related rights, to effect certain amendments that are necessary to ensure consistency with the MPRDA, 2002, and to amend the Deeds Registries Act, 1937 (Act 47 of 1937), so as to transfer the functions relating to the registration of rights to minerals from the ambit of the Act into the duties and functions of the Director-General of the Department of Minerals and Energy.

The Precious Metals and Diamonds General Amendment Bill, released for public comment in 2004, amends the Diamond Act, 1986 (Act 56 of 1986), and Chapter XVI of the Mining Rights Act, 1967 (Act 20 of 1967), and was expected to be finalised in the 2004/05 financial year. The main objective of these amendments is to provide for the rationalisation of the regulation of matters pertaining to the downstream development of precious metals and diamonds, to promote equitable access to the nation's precious metals and diamonds, and to promote local beneficiation of these minerals.

## Mine environmental management

Mine environmental management forms an integral part of mineral-resource management. It focuses on the following national priority programmes:

- The strengthening of enforcement to prevent mining legacies from occurring. This relates to

the implementation of the MPRDA, 2002 and other short- and long-term strategies to strengthen environmental enforcement.

- Identifying mine-pollution 'hot spots' and implementing additional measures, norms and standards to address and manage pollution within these areas.
- Rehabilitation of abandoned and ownerless mines.

To facilitate the implementation of these priorities, the *Phephafatso* (meaning 'clean-up' in Setswana) Strategy was developed. The Strategy is not only an initiative of the Department of Minerals and Energy, but is a co-operative government initiative supported by the mining industry, various parastatals and other role-players. Further linkages to this Strategy have been made with the Council for Scientific and Industrial Research (CSIR).

To address mine-water pollution problems within the Witwatersrand gold-mining 'hot spots', the Department, in conjunction with the Council for Geoscience and several other government departments, has developed a comprehensive strategy to address the polluted underground water that has been a hindrance for many years.

This strategy includes measures to prevent water ingress into mines.

Such preventative measures will reduce the impact on the environment and substantially decrease mining costs within the Witwatersrand gold-mining area. For the prevention of water ingress, a work programme aimed at engineering interventions in the central and East Rand mining basins was implemented in 2003/04. By mid-2004, the work plan was well underway and research in terms of best practices for closure of openings and the prioritisation of work was in progress.

## Mining outcomes of the World Summit on Sustainable Development (WSSD)

Representatives from nearly 200 countries assembled at the WSSD in Johannesburg in September 2002 to reaffirm their commitment to sustainable development.



In April 2004, the Minister of Minerals and Energy, Ms Phumzile Mlambo-Ngcuka, launched the first project of the beneficiation leg of the Mining Charter.

The South African Mineral Pavilion is situated at the Johannesburg International Airport. The Pavilion showcases the country's vast array of mineral resources as well as jewellery designs of local producers.

The Pavilion is the result of proposals contained in the Mining Charter to develop the country's minerals-beneficiation industry beyond mining and processing.

The Pavilion is a partnership between Harmony Gold, Mintek, the Airports Company of South Africa, and the departments of Minerals and Energy and of Arts and Culture.

As a follow-up to the WSSD outcomes for mining, the Department of Minerals and Energy finalised a strategy with specific programmes, plans and time frames to achieve the objectives and priorities with regard to the implementation of the Johannesburg Plan of Implementation (JPI).

The WSSD outcomes for mining include:

- poverty eradication
  - changing unsustainable patterns of consumption and production
  - protecting and managing the natural resource base for economic and social development
  - globalisation
  - initiatives for sustainable development in Africa.
- Apart from the national processes being established to take the WSSD outcomes forward, international processes and structures such as the African Mining Partnership will be established to champion, among others, the New Partnership for Africa's Development's (NEPAD) mining and mineral-related initiatives. The Global Mining Dialogue was also established to promote WSSD mining outcomes in the international arena.

The Dialogue has achieved its objective of bringing together interested governments to prepare the launch of the Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development.

The outcome was achieved at the second preparatory meeting of the Global Dialogue on Mining/Metals and Sustainable Development that took place in Geneva, Switzerland, in June 2004.

The JPI has implications for a number of national departments, because of its integrated nature, to address poverty eradication, sustainable production and consumption, management of the natural resources base and socio-economic aspects. Many of the relevant national departments have been requested to submit follow-up action plans to the Department of Environmental Affairs and Tourism. The departments' input ranges from national to international actions as well as policy reform and priorities.

### **Mineral and Mining for Sustainable Development**

An international initiative as well as a southern African initiative for sustainable development have

been undertaken. The purpose of these initiatives is to undertake research into sustainable development through mining, to identify critical issues and priorities, and to make recommendations regarding the implementation of such initiatives.

The key challenges include the following:

- poverty alleviation through employment, job creation, skills development and training, and ensuring that communities benefit from the exploitation of natural resources
- addressing the social and environmental legacies of the past
- HIV and AIDS
- ensuring the viability of the mining industry on global, national and regional bases where markets for minerals must develop in a way that enables rather than limits the transition to sustainable development, notably in terms of internalising costs over time, while maintaining viable enterprises and rewarding good practice
- good governance and strengthening enforcement
- issues relating to market access and in particular the beneficiation of minerals.

A task team has been established, consisting of government departments, the mining industry, labour and non-governmental organisations. Its role is to determine how the recommendations emanating from the initiatives can be taken forward.

### **Sustainable development on the African continent**

African Mining Ministers met in Cape Town in February 2004 to launch the African Mining Partnership (AMP) to discuss issues of common interest in mining, and to adopt projects which were recommended during the second Steering Committee meeting held in Accra, Ghana, in October 2003.

The following projects were discussed and adopted:

- beneficiation
- artisanal and small-scale mining
- human resource development (HRD)
- environment/sustainable development
- promoting foreign investment and indigenous/local participation in mining ventures.

The outcomes of the meeting resulted in an implementation plan, which identified the following projects:

- the first project entails assessing the environmental impact of African mining and mineral-processing operations and associated infrastructure, and evaluating the expected impact of future mining and mineral processing operations and associated infrastructure
- the second project entails synergising the AMP environment/sustainable development strategy with the WSSD Outcomes For Mining and with the JPI, taking into consideration the AMP priorities.

The project proposals of the abovementioned projects were presented to the Steering Committee of the AMP in Egypt in July 2004.

### Rehabilitation of mines

Government follows an integrated and co-operative approach with regard to the rehabilitation of South Africa's asbestos mines. A dedicated programme for the rehabilitation of derelict and ownerless asbestos mines/dumps has been implemented and the Department rehabilitated about 60% of the existing 578 asbestos dumps located in Limpopo, Northern Cape and North West. It is envisaged that the remaining rehabilitation work will be completed within six years.

The Department of Minerals and Energy, in co-operation with the Department of Water Affairs and

Forestry and other role-players, implemented urgent short-term rehabilitation measures at the Transvaal and Delagoa Bay mines.

The initial work programme has been expanded to address the following:

- ingress of air and water into underground mine workings
- spontaneous combustion in underground workings
- acid mine water egress from the workings
- unpredicted collapses of the mine workings and surface areas (sinkholes).

An evaluation of the options for rehabilitation of the colliery has identified two broad methods:

- re-mining and selective rehabilitation
- fall-back options: covering the site with ash or sealing off the mine perimeter and flooding followed by rehabilitation.

Three derelict/ownerless coal-mining sites were identified in the Vierfontein Colliery area, situated near Orkney in the Free State. It was envisaged that the sinkholes identified will be rehabilitated during the 2004/05 financial year.

### Excellence in Mining Environmental Management (EMEM) Award System

The EMEM Award System was implemented in March 2000 to motivate the mining industry to excel in environmental management, and to recognise those mining companies which have excelled in their field. The EMEM Awards are awarded to regional and national companies.

## Black Economic Empowerment (BEE)

The New Africa Mining Fund (NAMF), a private equity fund, was established in 2002 to exclusively finance exploration activities, while facilitating the entry of HDIs into the mining industry.

No other institution in South Africa provides such funding.

By June 2004, the NAMF had received 130 applications for funding. During 2004, eight BEE transactions to the value of R10 billion were finalised.



The Department of Minerals and Energy supports various organisations aimed at empowering women in the minerals and energy fields.

These include:

- Women in Nuclear South Africa, which communicates the benefits of nuclear technology to the public.
- Women in Oil and Energy, which supports women working in the oil and energy fields and develops renewable energy projects.
- South African Women in Mining Association (SAWIMA), which is positioning itself as a role-player in major mining transactions. SAWIMA has formed an investment company, which champions business opportunities.

## **Mining industry**

Mining continues to play an important role in the national economy. Preliminary figures for 2003 indicate that South Africa's mining sector contributed R78,5 billion of gross value added compared with 2002. Although this is a 1% decrease which is equivalent to R2,08 billion, the mining industry remains the major contributor to South Africa's economy.

The improvement in the exchange rate has reversed the positive effect that would have been experienced by local producers due to the relatively higher revenues in Dollar terms, as compared with 2002 for major commodities. Some of the local producers have scaled down their projected expenditure on expansion projects while others may retrench workers in marginal operations.

Gold mining continued to play a dominant role in the sector. In 2003, preliminary figures for foreign revenue earnings stood at US\$4,4 billion, compared with those of platinum-group metals (PGMs), which totalled US\$3,8 billion.

Even with greater mineral value addition at R31,0 billion, South Africa continues to export a very high proportion of its raw mineral resources.

Employment has continued the slight upturn which was first experienced in 2002, to a workforce of 430 870 in 2003, a 4,3% rise. This sustained rise can be attributed to expansions in the PGM sector.

There is still potential for growth in the exploitation of minerals in the country, especially in the sectors where the country is ranked number one in terms of reserves. For example, in manganese, chrome and the PGMs, South Africa has 80%, 72,4% and 87,8% of world reserves respectively.

Over the last few years, South African mining houses have transformed into large focused mining companies that include Anglo Platinum, Anglogold, De Beers, Implats and Iscor.

The Government is the only shareholder of Alexkor, a diamond mine situated on the west coast in Namaqualand. Mining takes place on land and in certain sea concession areas.

The Alexkor Limited Amendment Act, 2001 (Act 29 of 2001), provides for the sale or disposal of

shares held by the State. However, new management has been appointed and over the past two years, the mine has turned around to profitability.

Government is involved in the Alexkor Diamond Mine Board and Audit Committee.

In October 2003, the Constitutional Court returned the land and mineral rights owned by Alexkor to the Richtersveld community which was forcibly removed from the land in the 1920s.

Negotiations regarding the future of the mine are taking place.

## **Mineworkers**

Gold mining, with 45,7% of the mining industry's labour force, was the largest employer in 2003, followed by PGM mining with 28,8%. The coal industry employed 11% of the labour force in 2003.

Taking into account the multiplier effect of the supply and consumer industries, including dependants, many millions rely on the mining industry for their livelihood.

Employers and trade unions in the mining industry have agreed to establish measures that will help create jobs and alleviate poverty. The parties committed themselves to ensuring that skills development becomes a priority in the industry.

## **Mine health and safety**

The purpose of the MHSI is to reduce mining-related deaths, injuries and diseases through the establishment of national policy, legislation and systems to regulate and enforce health and safety, and support training in the mining industry.

The Chief Inspector is also chairperson of the boards of the Mine Health and Safety Council (MHSC) and the Mining Qualifications Authority (MQA).

The main strategic objective of the MHSI is to improve occupational health and safety in mines through the establishment and promotion of national policy, legislation and systems to regulate, monitor, audit and inspect mines; contribute to the development of qualifications, skills programmes and learnerships in the mining industry; and provide technical advice to the mines.

There has been a steady improvement in safety performance during the past 10 years, but all stake-

holders agree that the fatality and injury rates remain high especially in underground gold mines. Coal, platinum and other commodity mines have shown a satisfactory performance in relation to international benchmarks. This necessitated a concerted effort to improve the prevention of occupational accidents.

The prevention of occupational diseases has received increased attention in the years following the Leon Commission of Inquiry (1994) and the coming into effect of the Mine Health and Safety Amendment Act, 1997 (Act 72 of 1997).

There has been a steady appreciation of the need to apply more resources to deal with occupational health matters. Tuberculosis (TB) associated with exposure to silica dust is a growing occupational health concern and is receiving priority attention in the mining industry. The increase in prevalence of HIV-infection has led to a doubling in new TB cases and increased mortality. Noise-induced hearing loss

has also been recognised as a major occupational health risk in the South African mining industry.

The State and its tripartite partners in the MHSC have identified and are addressing the following four key national occupational health and safety priorities:

- prevention
- culture
- capacity
- governance.

Proposed key measures for the prevention of machinery-related accidents were identified by the Minister of Minerals and Energy, Ms Phumzile Mlambo-Ngcuka, during the National Union of Mineworkers Policy Conference in February 2003.

These include:

- the maintenance of track work to prevent derailment
- the development of a traffic-control system to prevent the collision of vehicles
- a clearance of at least 500 mm between rolling stock and any object to allow sufficient space for pedestrians.

In the next three years, the MHSI will focus on addressing hazards relating to mine falls, machinery and occupational health. Work will also continue to support HRD in the industry, inquiries into recent major accidents, developing and improving occupational health and safety databases, and bringing about the integration of occupational health and inspectorates at national level.

The Biennial Tripartite Mine Health and Safety Summit was held in October 2003. Representatives from the State, employers and labour agreed on milestones to be achieved by 2013, with the ultimate goal being to achieve zero accident and injury rates and the elimination of exposure to health hazards.

These include:

- eliminating silicosis and noise-induced hearing loss
- reducing the fatality rate in the gold-mining sector by 50%
- reducing the fatality rate in coal, platinum and other mines by 20%.

Policy, legislation and implementation plans are being developed to establish a new interdepartment-

South Africa's mineral reserves, 2003

| Commodity             | Unit | Reserves | %    | World ranking |
|-----------------------|------|----------|------|---------------|
| Alumino-silicates     | Mt   | 51       | 37,4 | 1             |
| Antimony              | Kt   | 250      | 6,4  | 4             |
| Chrome ore            | Mt   | 5 500    | 72,4 | 1             |
| Coal                  | Mt   | 33 814   | 3,7  | 7             |
| Copper                | Mt   | 13       | 2,0  | 14            |
| Fluorspar             | Mt   | 80       | 16,4 | 2             |
| Gold                  | t    | 36 000   | 40,7 | 1             |
| Iron ore              | Mt   | 1 500    | 0,9  | 11            |
| Lead                  | Kt   | 3 000    | 2,1  | 7             |
| Manganese ore         | Mt   | 4 400    | 80,0 | 1             |
| Phosphate rock        | Mt   | 2 500    | 5,0  | 4             |
| Platinum-group metals | t    | 70 000   | 87,8 | 2             |
| Silver                | kt   | 10       | –    | –             |
| Titanium minerals     | Mt   | 244      | 27,8 | 2             |
| Uranium               | Kt   | 298      | 1,6  | 4             |
| Vanadium              | Kt   | 12 000   | 44,0 | 1             |
| Vermiculite           | Mt   | 10       | 40,0 | 2             |
| Zinc                  | Mt   | 15       | 3,3  |               |
| Zirconium minerals    | Mt   | 14       | 17,4 | 2             |

Mt=megaton, Kt=kiloton, t=ton

Source: Minerals Bureau

tal national institution, in addition to the MHSI, to be responsible for the prevention and compensation aspects of occupational health and safety. Transition to the new system is likely to take place in the Medium Term Expenditure Framework period.

The fatality rate for 2003 was 0,63 per 1 000 people at work per year, or 264 fatalities. This is an improvement on the previous year's rate of 0,76 per 1 000 people, or 293 fatalities. The reportable injury rate for 2003 was 10,30 injuries per 1 000 people at work, or 4 290 injuries. The corresponding figure for 2002 was 11,5 per 1 000 people, an equivalent of 4 461 injuries.

Against a backdrop of expansion in the gold, platinum and small mining areas, and particularly severe personnel capacity constraints in the platinum and small-mining sector, these results suggest that considerable effort was made on the part of the Inspectorate and certain industry stakeholders to prevent safety performance from deteriorating.

The Department benchmarks local mine fatality and accident rates against the international Ontario Hard Rock Mines Standard. According to these criteria, South Africa's platinum mines are performing well whereas its gold mines still require improvement. The Inspectorate has completed a number of inquiries into major accidents.

## Human resource development

The overall aim of the MQA is to facilitate the development of appropriate knowledge and skills in the mining, minerals and jewellery sectors, to:

- enable the development and transformation of the sector
- contribute to the health, safety and competitiveness of the sector
- improve access to quality education and training for all
- redress past inequalities in education and training.

The MQA was established as a Sector Education and Training Authority under the leadership of the Department of Labour. The responsibilities of the MQA are to:

- develop and monitor the implementation of a sector skills plan

- register skills-development facilitators at workplaces within the sector
  - approve work skills plans and annual training reports of companies in the sector
  - develop unit standards and qualifications
  - maintain the quality of standards, qualifications and learning provision in the sector
  - establish, register, administer and promote learnerships
  - administer existing apprenticeship systems
  - administer and disburse skills-development levies.
- The MQA's output (unit standards, skills programmes, qualifications and accreditation) have been aligned with the policies of the Mining Charter and the legislative programme of the Inspectorate, through the active participation of the latter in the organisational structure of the MQA. This resulted in 52 priority learnerships and 558 learners being registered by November 2003. The MQA also registered 21 ongoing skills programmes.

The MQA has made significant progress in the following areas:

- sector skills planning
- standard setting
- learnerships, skills programmes, apprenticeships and learning material
- education, training and quality assurance.

## Chamber of Mines

Established in 1889, the Chamber of Mines consists of independent mining finance corporations, individual mines and mining companies. The members account for more than 85% of South Africa's mineral output.

The Chamber of Mines provides an advisory and service function to its members and to the industry on a co-operative basis, in areas such as industrial relations; education and training; security and healthcare; technical, legal and communication services; and the provision of statistical data.

The following services are provided by subsidiary companies to the South African mining industry and, in some instances, also to customers outside the mining industry: training; examination administration; visits to operational gold and diamond mines;

the monthly newspaper *Mining News*; mine-rescue; environmental management; and centres for human development.

Other areas of industry networking include:

- the Employment Bureau of Africa (TEBA)
- TEBA-Bank, providing efficient and cost-effective banking services for mineworkers
- Rand Mutual Assurance, providing workers' compensation benefits for accidental injury or death arising out of and in the course of employment
- Rand Refinery Ltd, the world's largest gold refinery
- the Nuclear Fuels Corporation (NUFCOR)
- Colliery Technical Services, which includes the Colliery Training College
- Rescue Drilling Unit

#### South Africa's mineral production, 2003

| Commodity             | Unit | Production | %    | World rank |
|-----------------------|------|------------|------|------------|
| Aluminium             | kt   | 735        | 2,6  | 9          |
| Alumino-silicates     | kt   | 165        | 29,8 | 2          |
| Antimony              | t    | 5 291      | 5,4  | 3          |
| Chrome ore            | kt   | 7 405      | 49,0 | 1          |
| Coal                  | Mt   | 239        | 4,7  | 5          |
| Copper                | kt   | 121        | 0,9  | 15         |
| Diamonds              | kcar | 11 914     | 9,1  | 5          |
| Ferrochromium         | kt   | 2 813      | 46,0 | 1          |
| Ferromanganese        | kt   | 843        | 10,2 | 2          |
| Ferrosilicon          | kt   | 184        | 8,9  | 5          |
| Fluorspar             | kt   | –          | –    | –          |
| Gold                  | t    | 373        | 16,4 | 1          |
| Iron ore              | Mt   | 38         | 3,5  | 7          |
| Lead                  | kt   | 4,0        | 1,3  | 12         |
| Manganese ore         | kt   | 3 501      | 14,8 | 1          |
| Nickel                | kt   | 41         | 3,3  | 9          |
| Phosphate rock        | kt   | –          | –    | –          |
| Platinum-group metals | kg   | 266 150    | 57,3 | 1          |
| Silicon metal         | kt   | 49         | 4,9  | 7          |
| Silver                | t    | 80         | 0,4  | 20         |
| Titanium minerals     | kt   | –          | –    | –          |
| Uranium               | t    | 758        | 2,1  | 10         |
| Vanadium              | kt   | 27         | 41,0 | 1          |
| Vermiculite           | kt   | 183        | 41,3 | 1          |
| Zinc in minerals      | kt   | –          | –    | –          |
| Zirconium minerals    | kt   | –          | –    | –          |

Mt=megaton, Kt=kiloton, t=ton, kg=kilogram, k car=kilocarats

Source: Minerals Bureau

- Collieries Environmental Control Services
- the CSIR Mining Technology Division (Miningtek).

## Junior and small-scale mining

The National Small-Scale Mining Development Framework was created to assist small-scale miners with the challenges they face. The small-scale mining sector makes a significant contribution to job creation in the mining industry.

It is estimated that about 1 000 jobs can be created for every seven to 10 sustainable small-scale mining projects assisted. Experience has shown that it is not enough just to provide institutional support; there is a need to involve technical partners or business professionals to mentor the project to its completion.

The target market for assistance by the Framework are:

- illegal or unacceptable operations with the aim to legalise and convert them into sustainable operations
- undercapitalised operations which require expansion or optimisation
- first-time entrepreneurs interested in greenfield projects.

Efforts are being made to raise finance to capitalise the 25 projects that the Framework has approved for support. The Framework assisted the approved projects with the following services:

- resource evaluation
- project development and training
- environment planning
- business planning
- financial guidance.

A total of R15,1 million was allocated to small-scale mining projects in 2003/04.

## Mineral wealth

South Africa's mineral wealth is found in diverse geological formations, some of which are unique and extensive by world standards. Some of the country's minerals include:

- Gold – the unique and widespread Witwatersrand Basin yields some 98% of South Africa's gold output.
- Diamonds (in kimberlites, alluvial and marine) – the country is among the world's top producers.
- Titanium – heavy mineral-sand occurrences containing titanium minerals are found along the coasts.
- Manganese – enormous reserves of manganese are found in the sedimentary rocks of the Transvaal Supergroup.
- PGMs and chrome – these minerals occur in the Bushveld Complex in Mpumalanga, Limpopo and North West. More than half of the global reserves of chrome and platinum are found in this deposit.
- Coal and anthracite beds occur in the Karoo Basin in Mpumalanga, KwaZulu-Natal and Limpopo.
- Copper phosphate, titanium, iron, vermiculite and zirconium are found in the Phalaborwa Igneous Complex in Limpopo.

South Africa's reserves of five commodities rank highest in the world. These are:

- manganese
- chromium
- PGMs
- gold
- alumino-silicates.

The small domestic market for most commodities means that South Africa's mineral industry is export-orientated: for vanadium it contributes 79% of world exports, antimony 26%, alumino-silicates 38%, ferrochromium 57%, chrome ore 57%, and manganese ore and ferromanganese 22% and 24% respectively.

South Africa is the world's largest exporter of these commodities, as well as of gold, zirconium and vermiculite. Other important export commodities include coal and titanium minerals.

Because of this vast mineral resource base, South Africa is, to a large degree, self-sufficient with respect to the supply of minerals.

However, some minerals and mineral products need to be imported due to an insufficiency of local resources or the fact that their deposits in South Africa cannot be economically exploited.

Another factor is that certain specialised grades and products are not produced in South Africa.

South Africa's total primary minerals decreased by 12,6% to R117,7 billion in 2003. Total processed mineral sales increased by 10,0% from R30,9 billion in 2002 to R27,8 billion in 2003.

The combined total for primary and processed mineral sales is estimated to have decreased by 12,2% from R165,7 billion in 2002 to R145,5 billion in 2003.

Domestic primary mineral sales revenue increased in 2003 by 12,8% to R30,9 billion, from 27,4 billion in 2002.

The value of exports of primary minerals in 2003 decreased by 19,1% to R86,8 billion.

The Directorate: Mineral Economics (Minerals Bureau) of the Department of Minerals and Energy monitors and analyses all mineral commodities with regard to South African and world supply and demand, marketing and market trends.

Full details of South Africa's mineral industry (including the individual commodities) and its recent performance are provided in the Directorate's annual review.

The recent performance of the more important individual commodities and of the different mineral sectors is summarised as follows:

## **Gold**

World demand for gold decreased by 1,5% to 3 978 tons (t) in 2002. The average gold price traded at a five-year high of \$364/oz.

World mine supply decreased by 36 t to 2 587 t, but South African gold production fell by 6,4% to 373,1 t in 2003. Provisional data for 2003 indicates that total gold sales declined by 19,7% to \$4,38 billion.

## **Coal**

Investments in new coal-mining and transport infrastructural developments are still awaiting prospects of sustained strong activity and firm prices.

## **Platinum-group metals**

South African PGM production increased by 12,5% to 266 t in 2003, while PGM revenue increased by

14,8% to \$3,8 billion. The average platinum price for 2003 was 28% higher at \$692/oz, while the average palladium price was 40,0% lower at \$201/oz.

Due to the sharply increasing strength of the Rand, rising local costs and inflation with lower prices for palladium and rhodium, Anglo Platinum, South Africa's largest PGM producer, announced their decision to slow down the development of several new projects.

### **Non-ferrous minerals**

Refined copper, nickel, cobalt, titanium and zirconium concentrates dominate this sector, with support from zinc, lead and arsenic concentrates. The sector contributes some 12% and 4% respectively to total primary local sales and total primary export sales. About 44% of total revenue is from local sales for further added-value operations.

### **Ferrous minerals**

This sector consists of the ores of iron, manganese and chrome, and is dominated by iron ore. It has been a leading performer in the primary minerals industry in recent years, with revenue in Dollar terms growing at about 3% annually. Demand depends on the fortune of the world's steel and stainless steel industries.

Export earnings from ferrous minerals fell a considerable 26,5% from R5,66 billion in 2002 to R4,16 billion in 2003, as higher Dollar earnings were severely discounted by a much higher average Rand-Dollar exchange rate ratio for 2003. The strong Rand also affected total ferrous sales, which fell by 15,3% to R6,81 billion.

### **Industrial minerals**

This sector comprises a wide variety of mineral products, from which over 70% of revenue is local sales. In Dollar terms, domestic total sales increased by 49,2% in 2003 to \$564 million. In Rand terms, local sales increased by 7,5% to the value of R4,3 billion, and export sales decreased by 10,8% to R1,4 billion.

During 2003, 84% of local sales comprised limestone and lime (28%), phosphate rock concentrate

(data withheld), aggregate and sand (29%) and sulphur (6%).

Exports were dominated by dimension stone (57%), vermiculite (10%), andalusite and fluorspar (11% each), and phosphate rock concentrate (data withheld).

### **Processed minerals**

Ferro-alloys and aluminium dominate this sector, with solid support from titanium slag, phosphoric acid, vanadium, zinc metal and low-manganese pig-iron. Through investment in beneficiation, it has been the outstanding performer in the mineral industry over the last 20 years, with revenue in Dollar terms growing by 6,3% annually.

Weaker international prices during 2002 were responsible for processed mineral sales falling some 5,5% compared with 2001.

### **Other minerals**

This sector is dominated by diamonds, with support from hydrocarbon fuel, uranium oxide and silver. Sales revenue was boosted enormously in 2000 by diamond sales that were held back from 1999, and by a strategy to amortise commercial diamond inventories.

After three consecutive years of falling earnings, total sales of other minerals increased by some 31% in 2003 to \$1 258 million.

New investment potential remains strong in this sector, which has recovered enormously through new investments in operations since 1994, compensating for the rapid demise in the demand for uranium oxide in nuclear applications since the late 1980s.

## **Energy**

### **Energy in the economy**

Energy comprises about 15% of South Africa's Gross Domestic Product (GDP), creating employment for about 250 000 people. The total electricity sales by Eskom in 2003 grew to 196 980 gigawatt-hour (GWh). The peak demand on the integrated system totalled 31 928 megawatts (MW). Total liquid-fuels sales in 2001 grew by 0,3% to

20 934 million litres (ML). These figures demonstrate the growth of the South African economy and the importance of energy as a key driver of the country's economy.

Its energy intensity is above average, with only 10 other countries having higher commercial primary energy intensities. This high-energy intensity is largely a result of the economy's structure, with its dominating large-scale, energy-intensive primary mineral beneficiation and mining industries.

In addition, there is a heavy reliance on coal for the generation of most of the country's electricity and a significant proportion of its liquid fuels. Furthermore, South Africa's industry has not generally used the latest in energy-efficient technologies, mainly as a result of relatively low energy costs.

Government has been persistently engaging members of the Organisation of Petroleum Exporting Countries through diplomatic channels to increase production.

## Energy efficiency

Significant potential exists for energy efficiency improvements in South Africa in all economic sectors, the largest potential being in industry, which uses 68% of all electricity.

The savings potential of the industrial sector could be as high as 50% for a number of reasons: the low cost of electricity is only a temporary phenomenon, energy-efficient technologies are more easily available than in the past and the payback periods are short. However, maximum benefits for the national economy will only be realised if energy efficiency is practised across all sectors, including mining, households, commercial buildings and transport.

The Draft Energy Efficiency Strategy, which was released for comment in May 2004, sets a national target for energy efficiency improvement of 12% by 2014.

These include economic and legislative means, norms and standards and appliance labelling, energy audits and management, promotion of energy-efficient technologies, as well as the promotion of public awareness and information about the benefits of energy-efficiency measures.

Interventions will be grouped into three phases according to the payback period, implementing 'easy-gain' measures in the first phase and 'long-term gains' in the third phase.

The barriers to implementing energy efficiency in the past have been the low cost of electricity and the lack of knowledge among the public about the benefits of energy-efficient technologies. However, the situation is set to change. The commitment to sustainable development and cleaner energy utilisation, the low cost of energy-efficient technologies, and, above all, the cost-effectiveness of energy efficiency (including demand-side management on behalf of the electricity utilities) compared with the great expenditure involved in building new power-generation capacity, are driving government policy in a new direction.

## Energy demand by the economic subsector

### Households

Energy consumed by households represents some 17% of the country's net use. Most household energy is obtained from fuel wood (50% of net household energy), primarily in rural areas, with the remainder coming from coal (18%), illuminating paraffin (7%) and a small amount from liquid petroleum gas.

Rural households comprise the majority of poor homes and are characterised by severe poverty. In terms of basic energy services, their energy 'poverty' is exacerbated by the increasingly widespread scarcity of fuel-wood resources. Wood and paraffin are their main energy sources, with few having access to electricity.



The Department of Minerals and Energy, in conjunction with Eskom and the National Electricity Regulator, launched National Energy Efficiency Month under the theme *Save Energy, Save Money* on 1 May 2004.

The aim is to show the public how to conserve energy in their homes, businesses and industries, while saving money.

### Productive sectors

Industry and mining are the most important subsectors in terms of energy consumption. These sectors use mainly electricity and coal as energy sources.

The balance comes largely from coke and blast-furnace gases and small amounts of heating oils.

The mining industry depends heavily on electricity. Mineral and metal processing uses large amounts of electricity and coal, mostly in large-scale mineral-beneficiation processes. Base metals, the largest single industrial energy-consuming subsector, is also by far the most energy-intensive one.

The food sector shows a high total use and relatively high intensity, although, in terms of value added, its energy requirements are very modest in comparison with the basic mineral and metal industries. The chemical and paper and pulp industries also consume large amounts of energy at high intensities.

### Transport

Liquid fuels such as petrol and diesel account for 92% of the energy used for transport. Rail transport accounts for less than 5% of the total national electricity consumption. Petrol sales account for more than half of the total sales of local petroleum products.

Petrol and diesel consumption was 10 669 ML and 7 436 ML in 2003 respectively. Petrol and diesel account for about 72% of all petroleum products consumed in 2003. The total volume of liquid fuels sold during in 2003 was 25 338 ML.

The demand for petrol and diesel has remained relatively static over the last five years. The demand for jet fuel has, however, grown steadily since 1994 as a result of increased business and tourism activities.

Government has accepted a process of managed liberalisation for the liquid fuel industry.

The Petroleum Products Act, 1977 (Act 120 of 1977), has been amended to institute a licensing dispensation for participants in the liquid-fuel industry. The Petroleum Products Amendment Act, 2003 (Act 58 of 2003), was promulgated in 2003.

The Energy Regulator Bill, which will establish a National Energy Regulator, was before Parliament in 2004. It is expected that the Regulator, which will be responsible for the regulation of electricity, petroleum pipelines and gas, will be established in 2005.

### Coal

South Africa's indigenous energy resource base is dominated by coal. Internationally, coal is the most widely used primary fuel, accounting for about 36% of the total fuel consumption for the world's electricity production.

About 77% of South Africa's primary energy needs are provided by coal. This is unlikely to change significantly in the next decade, owing to the relative lack of suitable alternatives to coal as an energy source.

South Africa produces an average of 239 million tons (MT) of saleable coal annually, making it the fifth-largest coal producing country in the world.

Many of the deposits can be exploited at extremely favourable costs and, as a result, a large coal-mining industry has developed.

In addition to the extensive use of coal in the domestic economy, some 30% of South Africa's production is exported internationally mainly through the Richards Bay Coal Terminal, making South Africa the fourth-largest coal exporting country.

South Africa's coal comes from collieries ranging from among the largest in the world to small-scale producers. As a result of new entrants in the industry, operating collieries were increased to 64 during 2003. Of these, a relatively small number of large-scale producers supply coal primarily to electricity and synthetic fuel producers. About 51% of South African coal mining is done underground and about 49% is produced by opencast methods.

The coal-mining industry is highly concentrated, with four companies; Ingwe (BHPBilliton), Anglo



In 2004, Cabinet endorsed a five- to 10-year plan to grow a critical research and skills base to support the Pebble Bed Modular Reactor (PBMR) Programme and the South African nuclear industry.

The PBMR received an invitation to bid for the building of a reactor system in the United States of America.

Coal, Sasol and Eyesizwe, accounting for 79% of saleable coal production. Production is concentrated in large mines, with 13 mines accounting for 75% of the output.

South African coal for local electricity production is among the cheapest in the world. The beneficiation of coal, particularly for export, results in more than 63 MT of coal discards being produced annually.

Thirty percent of the run-of-mine coal mined for the export market, and between 15% and 30% of the run-of-mine coal mined for local demand (excluding power-station coal), is not saleable and therefore discarded.

The remainder of South Africa's coal production feeds the various local industries: some 61% is used for electricity generation, 24% for petrochemical industries (Sasol), 8% for the general industry, 4% for metallurgical industries (Iskor) and 3% for domestic heating and cooking.

The key role played by South Africa's coal reserves in the economy is illustrated by the fact that Eskom is the seventh-largest electricity generator in the world, and Sasol the largest coal-to-chemicals producer.

South Africa's coal reserves are estimated at 34 billion tons, and with South Africa's present production rate there should be more than 50 years of coal supply left.

By international standards, South Africa's coal deposits are relatively shallow with thick seams, which naturally make them easier and, most often, cheaper to mine.

Coal is expected to maintain its share of the overall electricity generation market until at least 2020. Total discards on the surface could reach more than 2 billion tons by the year 2020, should none of this material be utilised. As a result, the Department of Minerals and Energy is investigating ways to promote and encourage the economic use of the discards.

Environmental concerns pose the main challenge to coal as energy source. Not only does the burning of coal cause air pollution, but the mining activities to extract coal also have a severe impact on the environment. This is why the Department and the coal-

mining industry are fostering the introduction of clean coal technologies to the South African arena.

## **Nuclear**

The nuclear sector in South Africa is mainly governed by the Nuclear Energy Act, 1999 (Act 46 of 1999), and the National Nuclear Regulator (NNR) Act, 1999 (Act 47 of 1999), administered by the Department of Minerals and Energy; and part of the Hazardous Substances Act, 1973 (Act 15 of 1973), related to Group III & IV of hazardous substances, administered by the Department of Health.

The main organisations directly involved in the nuclear sector are the following:

- The Department of Minerals and Energy plays a leading governance role with regard to nuclear technology, non-proliferation and safety. The Minister of Minerals and Energy is the executive authority responsible for overseeing the Nuclear Energy Corporation of South Africa (NECSA) and the NNR.
- NECSA undertakes and promotes research and development in the field of nuclear energy, radiation sciences and technology, medical isotope manufacturing, nuclear liabilities management, waste management and decommissioning. It is a public entity reporting to the Minister of Minerals and Energy.
- The NNR oversees safety regulation of nuclear installations at NECSA, Pelindaba, Vaalputs Radioactive Waste Disposal Facility, the Koeberg Nuclear Power Station, certain mines and other small users. It is a public entity reporting to the Minister of Minerals and Energy.
- The Department of Health (Directorate: Radiation Control) issues licences for Group III haz-



The formation of government's Integrated Energy Centres (IECs) will facilitate job creation, help improve access to modern energy carriers, and educate the poor about how to use energy in a cost-efficient manner.

Seven IECs were expected to be launched in 2004/05. These will be situated in KwaZulu-Natal, the Eastern Cape, Northern Cape, North West and Mpumalanga.

ardous substances (electronic product generating X-rays, other ionizing beams, electrons, neutrons or other particle radiation or non-ionising radiation) and Group IV hazardous substances (radioactive material outside a nuclear installation and which does not form part of or is used or intended to be used in the nuclear fuel cycle, and which is used or intended to be used for medical, scientific, agricultural, commercial or industrial purposes).

- The Koeberg Nuclear Power Station is responsible for electricity generation. It is government-owned through the public entity, Eskom, which reports to the Minister of Public Enterprises.
- IThemba Laboratories is responsible for medical isotopes and medical applications. This public entity falls under the Department of Science and Technology.
- NUFCOR is responsible for uranium-ore refinement and export. It is privately owned by AngloGold.

The South African nuclear sector employs about 2 700 people. The Koeberg Nuclear Power Station contributes about 6% of total electricity, and contributions to GDP are in excess of R1,5 billion from uranium exports (last five years) and NECSA's direct commercial sales of about R300 million per year.

## **Liquid fuels**

South Africa consumed 21 267 ML of liquid-fuel products in 2002 and 25 338 ML in 2003. Thirty-six percent of the demand is met by synthetic fuels (synfuels) produced locally, largely from coal and a small amount from natural gas. The rest is met by products refined locally from imported crude oil.

The petrol price in South Africa is linked to the price of petrol in United States (US) Dollars in certain international petrol markets. This means that the domestic price is influenced by supply and demand for petroleum products in the international markets, combined with the Rand/Dollar exchange rate.

The National Petroleum, Gas and Oil Corporation of South Africa (PetroSA) was officially launched in Cape Town in October 2002.

The formation of the Corporation was the result of a merger between MossGas, Soekor and other assets managed by the Strategic Fuel Fund (SFF).

PetroSA is responsible for the exploration and exploitation of oil and natural gas, as well as the production and marketing of synthetic fuels produced from offshore gas at the world's largest commercial gas-to-liquids plant in Mossel Bay.

PetroSA's commitment to the safety and health of its workers led to the company winning the National Association of Clean Air Award for its Mossel Bay refinery operation.

The Petroleum Products Amendment Bill and the Petroleum Pipeline Bill were promulgated in 2003. The Department of Minerals and Energy established a monitoring team in 2002 to evaluate the sustainability of BEE deals in liquid fuels and the validity of BEE groups.

The Department also regulates the liquid-fuels industry and has played a pivotal role in the development of the Liquid Fuels Charter and the transformation of the industry. To track the effectiveness of the Charter, annual audits are conducted to ascertain the extent of participation by companies owned or controlled by HDIs.

A further challenge for the Department together with the Department of Environmental Affairs and Tourism is the commitment to a clean environment. In terms of Cabinet's decision of 2000, sulphur in diesel will have to be reduced and leaded petrol phased out by 2006.

## **Sasol**

The Sasol group of companies comprises diversified fuel, chemical and related manufacturing and marketing operations, complemented by interests in technology development, oil and gas exploration, and production.

Its principal feedstocks are obtained from coal, which the company converts into value-added hydrocarbons through Fischer-Tropsch process technologies.

The company supplies 41% of South Africa's liquid fuel needs. It also provides 200 000 direct and indirect jobs, contributes R34 billion annually to

South Africa's GDP, and produces 23% of the country's required coal.

Sasol operates in 23 countries on all continents, producing hundreds of fuel and chemical products for customers.

Among its recent international developments is an agreement signed with the Mozambican Government for the development of natural gas fields in that country, and the construction of a pipeline to Sasol's Secunda Plant in South Africa.

The pipeline was officially opened at the end of March 2004. It immediately raised South Africa's use of natural gas as primary energy supply source from 1,5% to 4,3% of total demand.

The pipeline is a joint venture between Sasol and the governments of South Africa and Mozambique.

The State retains the 25% share option in the gas pipeline project, through iGas, a subsidiary of the Central Energy Fund (CEF).

The initial capacity of the pipeline is 120 million giga-joules per year, equivalent to 4 000 MW.

Sasol listed its American Depository Receipts on the New York Stock Exchange on 9 April 2003.

The company's main projects during the last six months of 2003/04 included the following:

- Project Turbo – the fuels enhancement and polymers expansion project which is scheduled for commissioning in the last quarter of 2005
- the gas-to-liquid fuels projects in Qatar and Nigeria which are scheduled for start-up in December 2005 and July 2007 respectively
- the Arya Sasol polymers joint venture to build a world-scale ethane cracker and polyethylene plants in Iran, which are scheduled for commissioning from the fourth quarter of 2005
- the acrylic acid project which was commissioned during the first quarter of 2004.

### **Central Energy Fund**

The CEF is mandated by the State to engage in the acquisition, exploration, generation, marketing and distribution of any energy form, and to engage in research related to the energy sector.

The vision of the CEF is to become the leading commercially viable energy-development company in Africa. The CEF's mission is to actively pursue

economically viable opportunities in oil, gas, coal and renewable energy resources, and to provide access to sustainable and affordable energy.

The CEF group of companies focuses on a number of areas:

- exploration and production
- petroleum products and services
- promoting and marketing offshore and onshore exploration
- oil trading and tank terminal management
- renewable energy
- energy efficiency and climate change
- low-smoke fuels
- research and development
- gas infrastructure development
- oil pollution prevention and control.

The Fund's activities are housed in five active subsidiaries – PetroSA, Petroleum Agency SA (PASA), iGAS, the SFF Association and Oil Pollution Control South Africa.

### **Indigenous oil and gas resources and production**

The Department of Minerals and Energy is committed to the promotion of liquid petroleum gas which is cleaner, safer and which can serve as an efficient burning energy source. It is better burning fuel for cooking and heating. It does not generate smoke, dust and choking fumes like most other hydrocarbon fuels.

Government is committed to making it more affordable. It aims to pilot a different approach to the liquid petroleum gas retail sector before the end of 2004/05. A regulatory framework will also be developed.

PASA, the Department of Minerals and Energy's Agency responsible for the promotion of oil and gas exploration, has been successful in further encouraging international exploration companies to evaluate the country's oil and gas opportunities.

As a result of increased exploration activities, a better understanding of the potential for commercial oil and gas is being developed. PASA is following this with a detailed resource study.

The EM gas-field complex off Mossel Bay started production in the third quarter of 2000, and

will ensure sufficient feedstock to PetroSA to maintain current liquid-fuel production levels at 36 000 barrels (bbls) of petroleum products a day until 2009.

Parallel exploration is being carried out in various other sections of the Bredasdorp Basin off the coast of Mossel Bay in the Western Cape to locate reserves for PetroSA beyond 2009.

PetroSA's gas-to-liquid plant supplies about 7% of South Africa's liquid-fuel needs. The products are supplied to oil companies that market them under their own brand names.

PetroSA also produces anhydrous alcohols and speciality fuels that are exported and earn the company more than R500 million per year.

PetroSA's oilfield, Sable, situated about 150 km south off the coast of Mossel Bay, is expected to produce 17% of South Africa's oil needs.

The field, which came into operation in August 2003, was initially projected to produce 30 000 to 40 000 bbls of crude oil a day and 20 million to 25 million bbls in the next three years.

The net savings in foreign exchange to the country would be equivalent to PetroSA's bottom-line profit of between \$10 million and \$15 million a year.

PetroSA holds 60% working interest in Sable, while Dallas-based partner company Pioneer Natural Resources holds the remaining 40%.

PetroSA has offered 9% of its Sable interest for sale to a BEE group.

### **Import and export of fuel products**

The import of refined products is restricted to special cases where local producers cannot meet demand. It is subject to State control with a view to promoting local refinery utilisation.

When overproduction occurs, export permits are required and generally granted, provided that both South Africa's and other Southern African Customs Union members' requirements are met.

More diesel than petrol is exported, owing to the balance of supply and demand of petrol and diesel relative to refinery configurations. Although petrol and diesel make up 55% of total liquid-fuel exports, South Africa is also the main supplier of all other liquid fuels to Botswana, Namibia, Lesotho and Swaziland.

## **Gas**

In addition to coal gas and liquid petroleum gas, South Africa produced some 930 000 t of natural gas and 104 860 t of associated condensate in 2003.

The entire gas and condensate output is dedicated to PetroSA's liquid-fuel synthesis plant, and accounts for about 1,5% of total primary energy supply. Gas manufactured from coal accounted for 0,5% of net energy consumption, while liquid petroleum gas accounted for about 0,6%.

Natural and coal gas play separate roles in the energy system, with natural gas being used solely as a feedstock for the production of synthetic fuels, and coal gas as an industrial and domestic fuel.

However, current development of regional gas fields will lead to natural gas becoming a more important fuel in South Africa.

### **Infrastructure**

South Africa's gas infrastructure stretches from Sasolburg in the northern Free State, through the industrial areas of Vereeniging, Johannesburg and the East Rand, and from Secunda to Witbank, Middelburg, Newcastle, Richards Bay and Durban.

Through the Sasol Gas Division, Sasol Oil markets industrial pipeline gas produced by Sasol Synthetic Fuels and Sasol Chemical Industries to about 700 industrial customers. These customers are mostly situated in the greater Johannesburg-Pretoria region and the industrial areas of Witbank-Middelburg and Durban. Its pipeline network consists of about 1 500 km of underground pipelines.

Most of the remaining 10% of gas sales in South Africa is on selling of Sasol gas by Metro Gas in Johannesburg, which owns 1 300 km of distribution pipe, and supplies 12 000 domestic and 3 000 industrial customers.

The privatisation of Metro Gas was completed in 2000. It is now owned by Egoli Gas (Pty) Ltd, a joint venture company owned by Cinergy Global Power Inc. Egoli Gas intends to invest R276 million in Metro Gas.

Petronet owns and operates a gas pipeline, known as the Lily Line, which is about 600 km long

and transports methane-rich gas from Sasol's Secunda plant as far as the Durban area. Easigas (Shell) has a small liquid petroleum gas/air pipe network in Port Elizabeth. A privately owned company in Port Elizabeth distributes a small amount of liquid petroleum gas/air blend by pipe.

Industrial customers use 87% of the gas, and domestic consumers the rest. The supply of cost-competitive pipeline gas is complemented by the fuel oils range of low-sulphur residual and distillate fuel oils derived from coal and other synthesised forms, as well as crude oil.

PASA markets offshore gas exploration and exploitation.

The Gas Act, 2001 (Act 48 of 2001), aims to:

- promote the orderly development of the piped-gas industry
- establish a national regulatory framework
- establish the National Gas Regulator as the custodian and enforcer of the national regulatory framework.

To facilitate the movement of gas across international borders, a cross-border gas trade agreement with Mozambique has been signed.

## Electricity

South Africa, which supplies two-thirds of Africa's electricity, is one of the four cheapest electricity producers in the world. Ninety-two percent of South African electricity is produced from coal. Generation is currently dominated by Eskom, the national wholly State-owned utility, which also owns and operates the national electricity grid. Eskom currently supplies about 95% of South Africa's electricity.

In global terms, the utility is among the top 11 in generating capacity, among the top nine in terms of sales, and has the world's biggest dry-cooling power station.

Eskom was incorporated as a public company on 1 July 2002. It is financed by net financial market liabilities and assets as well as reserves.

While Eskom does not have exclusive generation rights, it has a practical monopoly on bulk electricity. It also operates the Integrated National High-

Voltage Transmission System and supplies electricity directly to large consumers such as mines, mineral beneficiators and other large industries. In addition, it supplies directly to commercial farmers and, through the Integrated National Electrification Programme (INEP), to a large number of residential consumers. It sells in bulk to municipalities, which distribute to consumers within their boundaries.

In 2003, Eskom electrified 75 396 homes against government's target of 64 107, thereby exceeding the target by 11 289 homes.

During 2003/04, 212 875 households were connected to the grid and 18 092 households were electrified using solar home systems. During 2003/04, 1 061 schools and 20 clinics were electrified.

The Department of Minerals and Energy commenced a two-year pilot study in 2002 to inform the free basic electricity policy to determine the most effective and financially viable delivery process. The Department is responsible only for formulating policy on free basic electricity, while the Department of Provincial and Local Government oversees implementation.

The Department started to develop a policy for using electricity prices as a macro-economic tool for inflation targeting in 2002. This work is ongoing and will also be used for attracting foreign investment to South Africa in the future, when the environment resulting from the restructuring of the electricity industry will be more competitive.

The electricity subprogramme also produced a regulatory framework during 2003 for the electricity supply industry (ESI), legislation that makes provision for and supports the regional electricity distributors (REDs), and the Multimarket Model (MMM) implementation plan. The programme has also begun to introduce multiplatforms for electricity trading.

In 2004, Eskom revealed plans to reintroduce three of its previously shut-down power stations into its generating capacity to cope with South Africa's increasing energy demand.

These power stations are Camden in Ermelo, Grootvlei in Balfour, and Komati, between Middelburg and Bethal. Built in the 1960s, these power plants were shut down as a result of excess

capacity in the 1980s and 1990s. However, with current projections indicating that, based on an average increase in electricity demand of 2,5% per year, the existing excess peaking capacity will be exhausted by 2007 and the baseload by 2010.

The first unit of Camden is expected to be returned to service in 2005, followed by Grootvlei in 2007 and Komati in 2010.

Between January 2003 and January 2004, South Africa increased its electricity output by 6,9%. South Africa's power producers generated 19 270 GWh of electricity during March 2004. Consumption rose by 4,8% to 17 640 GWh.

## Restructuring of the electricity supply industry

The recommendations approved by the Cabinet and which represent government's position on the ESI, include the following:

- To meet government's developmental and social objectives, Eskom retains no less than 70% of the existing electricity-generating market sector.
- The introduction of private-sector participation in the generation sector will be increased to 30% of the existing electricity-generating market sector.
- To ensure a meaningful participation of the private sector in electricity in the medium term, Eskom should not be allowed to invest in new generation capacity in the domestic market, other than in its existing capacity.
- To ensure non-discriminatory and open access to the transmission lines, and taking into consideration the financial stability of Eskom, government, in the medium term, is to establish a separate State-owned transmission company that

will be independent of generation and retail businesses, with a ring-fenced transmission-system and market-operation functions. Initially, this transmission company will be a subsidiary of Eskom Holdings and will be established as a separate State-owned company before any investments are made in current or new-generation capacity.

- Over time, an MMM electricity-market framework will ensure that transactions between electricity generators, traders and power purchasers take place on a variety of platforms, including bilateral deals, and future and day-ahead markets.
- A regulatory framework is in place that will ensure the participation of independent power producers, and that diversified primary energy sources be developed within the electricity sector without hindrance.
- The planning and development of transmission systems will be undertaken by the transmission company, subject to government's policy guidelines.
- Over time, and taking cognisance of the strategic objectives of the region, the Southern African Power Pool (SAPP) must develop into an independent system operator for the southern African regional grid system, so that public and private generating companies can participate in the Pool.
- Adapting the role of the regulatory system, which will include the reform of the legal framework defining the role of the National Electricity Regulator (NER), the development of a new framework for licensing, the adaptation of price-setting, and the creation of the capacity to monitor the effectiveness of the reformed ESI and ensure security of supply.



In October 2004, Cabinet authorised Eskom to begin planning for new capacity construction as estimates indicate that some R107 billion will be needed between 2005 and 2009 to meet South Africa's growing energy needs.

Cabinet decided that Eskom should provide 70% of that requirement. This will mean an investment of R84 billion by Eskom over the next five years.

The balance of R23 billion is being reserved for possible Independent Power Producer (IPP) entrants. The IPP process was expected to commence early in 2005.

## Restructuring of the electricity distribution industry (EDI)

The EDI restructuring process differs from most of the other State restructuring activities, as it addresses a number of diverse stakeholders, of which the most important are:

- Eskom

- municipalities' electricity departments
- provinces (related to their governance of municipalities)
- consumers, ranging from very large and electricity-intensive to small
- labour
- a number of government departments.

The normal State restructuring process needs to be modified at the entry level for EDI restructuring in such a manner that the ESI and the EDI restructuring processes are interlinked.

The EDI Holdings Company was registered in March 2003 and became operational in July 2003. It is responsible for the next phase which involves moving from the current fragmented EDI structure to the implementation of REDs.

The recommendations approved by the Cabinet, which represent government's position on the EDI, are the following:

- Endorsing the thrust of the revised *EDI Restructuring Blueprint Report*.
- The number of six REDs as both the Government's policy direction and the end-state model for the restructured EDI.
- The EDI restructuring implementation plan, especially the time frames, the establishment of the EDI Holdings Company and the transition, will ensure that Eskom and stronger municipalities support the weaker municipal distributors, and that RED 3 and RED 6 receive transitional financial support from the EDI Holdings Company. During 2003/04, the Company was expected to start transforming the EDI. Significant progress in the planning of the transformation of the ESI was made in 2003/04.
- Ongoing consultations with stakeholders such as new municipalities, the NER, Eskom, organised labour, customers, and provincial and local governments.

By May 2003, the industry was worth R30 billion and employed more than 30 000 personnel.

The work on demarcating the six new REDs has been completed. The REDs will own the distribution business of Eskom and municipalities.

In June 2004, Cape Town met the criteria to host the country's first RED. The criteria met by the city

include revenue management, customer performance and network configuration complexity.

## **National Electricity Regulator**

Established in 1995, the NER is a statutory body funded from a small levy imposed on electricity generators.

Legislation requires anybody wishing to generate, transmit or supply electricity to apply to the NER for a licence. This is issued on the basis of criteria which aim to promote and maintain a viable ESI.

In 2003/04, the NER:

- Continued to play a key role as a member of Government's Steering Committee for New Generation Capacity. It also provided advice to government on the 'managed liberalisation' of the generation and transmission sectors, as part of the build-up to a competitive market structure.
- Participated in and provided specific input to the following working groups:
  - ESI working groups (led by the Department of Public Enterprises)
  - EDI working groups (led by the Department of Minerals and Energy).
- Published the second National Integrated Resource Plan in May 2004.
- Regulated price increases applied for by licensees (including Eskom), resulting in customers enjoying considerable savings as a result of lower-than-applied-for electricity price increases.
- Managed the process to ensure that the Wholesale Electricity Pricing System (WEPS) is ready for implementation. In addition, the WEPS tariffs, modelling and simulation were tested and confirmed. WEPS is intended to regulate the wholesale price of electricity in South Africa when REDs are introduced.
- Broadened the Independent Power Producer (IPP) policy and licensing framework to include renewable IPPs and demonstration plants.
- Implemented the NER Power Quality Directive, resolved disputes between suppliers and customers, and dealt with customer complaints so that customers could have recourse at no or little cost.

- Developed the Draft Energy Efficiency Policy.
- Developed the Transmission Grid Code in consultation with industry stakeholders. These stakeholders represent entities that are foreseen to become Grid Code participants. The Grid Code Advisory Committee was established to advise the NER Board on matters relating to the drafting and amendment of the Grid Code.

The projected revenue of the NER over the medium term is about R68 million per year. The Regulator is in the process of increasing capacity to manage its expanded responsibilities for gas regulation and monitoring the roll-out and regulation of renewable energy technologies.

### **National and regional co-operation**

The NER was elected the first chairperson of the formalised African Forum for Utility Regulators. The NER was also the founding member of the Regional Electricity Regulators' Association (RERA) and the South African Utility Regulators' Association (SAURA), which were launched in September and October 2002 respectively. The NER is the chairperson of SAURA and a chairperson of one of RERA's portfolio committees.

The main purpose of RERA is to provide a platform for co-operation between independent electricity regulators within the Southern African Development Community (SADC) region.

### **Integrated National Electrification Programme**

The INEP remains the flagship of the Department of Minerals and Energy.

Government announced in February 2004 that it would allocate R200 million towards providing free, basic electricity to poor people in an effort to alleviate their living conditions.

The allocation is an extension of the Free Basic Electricity Policy which was developed and implemented in 2001.

By providing this basic service, government hopes to offer social relief to those who earn less than the national minimum wage levels.

Although users have access to a basic quantity of 50 Kilowatt-hours (KWh) per household per month in

terms of the Policy, users will pay the normal tariff for any consumption exceeding 50 KWh per month.

Rural households using solar energy will benefit from a limited operation and maintenance subsidy up to a maximum of R40 per household.

Rural solar-energy users will then be liable for paying any amount above the R40 monthly subsidy.

To make paraffin more affordable, the Department of Minerals and Energy removed the levying of Value-Added Tax on it.

The increased allocation/spending on basic electricity from R300 million to R500 million, took effect on 1 April 2004.

In March 2004, government announced that since the inception of the Programme, the overall amount spent on providing households with electricity was R12 million while R62 million was spent on non-grid electrification in 2003/04.

In April 2004, President Thabo Mbeki and Ms Mlambo-Ngcuka celebrated the electrification of 7,5 million households – an achievement of four million new electricity connections since 1994.

By that time, more than 50% of rural households in South Africa were electrified, whereas 80% of urban areas had access to electricity. More than 11 976 schools and clinics had been electrified using both grid and non-grid technology.

### **Southern African Power Pool**

The SAPP is the first formal international power pool in Africa.

The objectives of the SAPP are, among other things, to:

- co-ordinate and co-operate in the planning and operation of electricity power systems to minimise costs, while maintaining reliability, autonomy and self-sufficiency
- increase interconnectivity between SADC countries to increase the reliability of power supplies
- facilitate cross-border electricity trading
- fully recover costs of operations, and equitably share benefits, including reductions in generating capacity and fuel costs, and improved use of hydro-electric energy.

Member countries include Angola, Botswana, Lesotho, Malawi, Mozambique, Namibia, Swaziland,

Tanzania, Zambia, Zimbabwe and the Democratic Republic of Congo.

The SAPP is facing the following challenges:

- lack of infrastructure to deliver electricity
- lack of maintenance of infrastructure
- required funds to finance new investments
- insufficient generation – running out of excess capacity by 2007
- high losses.

The SAPP is considering a wholesale competition market called the MMM. The key drivers for considering wholesale competition are to:

- allow for private-sector participation and new players
- deregulate energy prices
- establish an independent regulator
- introduce competition and establish markets
- ensure rural electrification takes place driven by the different governments.

The SAPP has instituted a process of restructuring, aimed at expanding SAPP membership and allowing more participants into the SAPP.

The start of the Short-Term Energy Market is a good example of how the SAPP has opened up the electricity market to participants other than SAPP members.

The SAPP is encouraging members to review the energy tariffs and to become more competitive.

## **Biomass**

Fuel wood, which comes mainly from natural woodlands, is the primary source of energy used by households in most rural areas for the purposes of cooking and heating. In some areas, this is already almost completely depleted and in others it is under heavy pressure.

The total annual sustainable supply of wood from natural woodlands in communal rural areas is estimated at about 12 Mt. However, probably no more than half of it is usable as fuel wood. In addition to these sources, residues from commercial forestry total about 4,2 Mt per year. Much of this, as well as wood from bush clearing on commercial farmland, is increasingly being used as fuel.

To be effective, planning for a sustainable fuel-

wood supply requires decentralisation, understanding of local conditions and flexibility.

Supply-side interventions focus on satisfying a range of local needs and the realisation that community forestry involves not only the planting of trees, but also community participation, which is central to all activities.

Planning must ensure their integration into broader rural development, land use, natural resource management, and agricultural and energy planning. Interventions should build on the best indigenous practices identified. (See chapter 23: *Water affairs and forestry*.)

The Department of Minerals and Energy is participating with the Department of Science and Technology, National Treasury and stakeholders in a Joint Implementation Committee tasked with advising government and stakeholders on the creation of a market environment for biofuels. It is supporting the South African Bureau of Standards in testing South African plant oils to the European biodiesel standard. This should ensure high-standard biodiesel for blending which motor manufacturers also accept. The Department is also participating in workshops with the sugar industry and international interest groups who expressed an interest in ethanol production for liquid transport fuels.

## **Renewables**

Renewable energy sources, other than biomass, have not yet been exploited to the full in South Africa.

Cabinet approved the *White Paper on Renewable Energy* in November 2003, and in so doing, laid the foundation for the widespread implementation of renewable energy. The policy calls for a target of a 10 000 GWh contribution to final energy demand, to be realised by 2013. The Department aims to create an enabling environment for project developers to gain entry to this market. The Department has also strengthened international relationships in this area, through the support offered to partnerships established during the WSSD in 2002. These partnerships will overcome market barriers, promoting widespread use of sustainable energy solutions.

These include the Global Village Energy Partnership and the Renewable Energy and Energy Efficiency Partnership. The Department's capacity-building programme for renewable energy and energy efficiency (CaBEERE), which is funded by the Danish International Development Agency, is yielding significant value, both in capacity-building in the Department as well as the production of various strategies and studies to support the enabling environment created by government.

The White Paper addresses four key strategic areas, namely:

- financial instruments to promote the implementation of sustainable renewable energy through the establishment of appropriate financial instruments
- legal instruments to develop, implement, maintain and continuously improve an effective legislative system to promote the implementation of renewable energy
- technology development to promote, enhance and develop technologies for the implementation of sustainable renewable energy
- building capacity and education to develop mechanisms to raise awareness of the benefits and opportunities renewable energy offers.

Technological feasibility studies will be conducted for possible implementation in the medium to longer term.

These include:

- grid-connected wind farms
- wind farm/pumped storage as a means of addressing peak loads on the national electricity grid
- the local production and commercial dissemination of solar cookers which is a collaborative project between the German Development Agency and the Department of Minerals and Energy
- solar thermal-power generation, which is a collaborative programme with Eskom, also involving the SolarPACES Programme of the International Energy Agency
- small-scale hydropower
- landfill gas exploitation
- rural water supply and sanitation.

With Cabinet approving the *White Paper on Renewable Energy* in November 2003, the Department could proceed with the development of its Renewable Energy Strategy. This is essentially the implementation plan for widespread roll-out of the various technologies identified in a macro-economic study undertaken in the latter half of 2003.

The *White Paper on Renewable Energy's* target of 10 000-GWh renewable energy contribution to final energy consumption by 2013 was confirmed to be economically viable with subsidies and carbon financing. Achieving the target will add about 1 667 MW new renewable energy capacity, with a net impact on GDP as high as R1 071 million per year; additional government revenue of R299 million; additional income that would flow to low-income households of as much as R128 million, creating just over 20 000 new jobs; and water savings of 16,5 million kilolitres, which translates into a R26,6-million saving.

In addition to these benefits, the study also highlighted the technologies to be implemented first, based on the level of commercialisation of the technology and natural resource availability. These technologies include:

- sugar-cane bagasse for cogeneration
- landfill gas extraction
- mini-hydroelectric schemes
- commercial and domestic solar water heaters.

These technologies are to be deployed in the first phase of the target period, from 2005 to 2007. The Department will introduce nominal, once-off capital subsidies to assist project developers in producing economically sound projects that are readily financed by financial institutions.

## Solar

Most areas in South Africa average more than 2 500 hours of sunshine per year, and average daily solar-radiation levels range between 4,5 and 6,5 kWh/m<sup>2</sup> in one day.

The southern African region, and in fact the whole of Africa, is well endowed with sunshine all year round. The annual 24-hour global solar radiation average is about 220 W/m<sup>2</sup> for South Africa, compared with about 150 W/m<sup>2</sup> for parts of the

USA, and about 100 W/m<sup>2</sup> for Europe and the United Kingdom, making the local resource one of the highest in the world.

The solar resource is the most readily accessible in South Africa. It lends itself to a number of potential uses.

The country's solar-equipment industry is developing. Annual photovoltaic (PV) panel-assembly capacity totals 5 MW, and a number of companies in South Africa manufacture solar water-heaters.

The *White Paper on Energy Policy* identifies universal access to electricity as one of the primary goals of South Africa's energy policy.

To achieve this goal, it was decided to integrate non-grid technologies into the INEP as complementary supply-technologies to grid extension. A pilot programme has been launched to establish a limited number of public-private sector institutions in conjunction with the relevant municipalities to provide electricity services on an integrated basis. The service-provider will own and maintain the systems, allowing longer-term financing to ameliorate monthly payments. It will provide the service against a fee, payable as a monthly tariff.

Once the underlying managerial and funding issues have been resolved, the process will be expanded to cover all the rural areas.

Solar power is increasingly being used for water-pumping through the rural water-provision and sanitation programme of the Department of Water Affairs and Forestry.

Solar water-heating is used to a certain extent. Current capacity installed includes domestic 330 000 m<sup>2</sup> and swimming pools 327 000 m<sup>2</sup> (middle to high income), commerce and industry 45 000 m<sup>2</sup> and agriculture 4 000 m<sup>2</sup>.

In 2002/03, some 5 300 solar home systems were installed by the Department of Minerals and Energy, representing a 3% increase from 2001/02.

### **Solar-passive building design**

Houses and buildings in South Africa are seldom designed from an energy consumption or energy-efficiency perspective. The energy characteristics of low-cost housing are particularly bad, resulting in high levels of energy consumption for space heating in winter. The net result is dangerously high levels of

indoor and outdoor air pollution in the townships, due mainly to coal burning.

Research has shown that low-cost housing could be rendered 'energy smart' through the utilisation of elementary 'solar-passive building design' practice. This can result in fuel savings of as much as 65%. Such savings on energy expenditure will have a major beneficial impact on the household cash-flow situation. Energy-efficient homes may be constructed at the same direct cost (and lower life-cycle cost) as energy-wasteful houses. The challenge is to develop awareness and to ensure implementation of basic energy-efficiency principles.

### **National solar water-heating programme**

Water-heating accounts for a third to half of the energy consumption in the average household. In South Africa, this derives mainly from electricity, being the most common energy-carrier employed. Avoidance of this expenditure on household budgets could lead to significant improvements in the disposable incomes of the lower-income sector.

Furthermore, the equivalent of a large coal-fired power station (2 000 MW+) is employed to provide hot water on tap to the domestic sector alone. Since the inception of the accelerated domestic electrification programme through grid extension, a major distortion of the national load curve has emerged, with the early evening load peak growing significantly.

Modelling indicates that the introduction of solar water-heating can ameliorate the situation substantially.

Switching from electrical to solar water-heating can, therefore, have significant economic and environmental benefits.

There are economic benefits for home owners in reducing their energy bills. Expensive generation capacity to address load peaks will be obviated, and the introduction of new base-load capacity will be postponed. Benefits for the country include reducing greenhouse gas (GHG) emissions, and the release of scarce capital for other pressing needs.

The CEF is expected to instal some 250 domestic solar water-heaters as part of the CEF/GEF (Global Environment Facility) Solar Water-Heating

Programme, aimed at the commercialisation of domestic solar water-heating.

### Solar-thermal power generation

The minimum Direct Normal Radiation (DNR) to justify a combined solar thermal power plant is 1 800 kWh/m<sup>2</sup> per year. According to the Renewable Energy Resource Database, the area exceeding the minimum required DNR in South Africa covers about 194 000 km<sup>2</sup>. A 100-MW solar thermal plant requires roughly 3 km<sup>2</sup> (1800 kWh/m<sup>2</sup> per year). If 1% (1 940 km<sup>2</sup>) of the identified area is available for solar thermal power generation, South Africa has an installed potential of 64,6 GW, which is about 36 217 GWh/year.

Back-up and energy-storage constraints are limiting the wider economical utilisation of solar electricity generation (solar thermal and PV).

### Wind

Wind as an energy source is only practical in strong and steady wind areas. South Africa has fair wind potential, especially along the coastal areas. At present, however, wind is not used to generate electricity in this country. For the future, it presents itself as a competitive energy source.

Wind power is primarily used for water pumping, with about 300 000 windmills being used for watering livestock and supplying communities with water.

Wind energy is environmentally friendly and helps reduce global warming and GHGs.

The first wind-energy farm in Africa was opened at Klipheuwel in the Western Cape on 21 February 2003.

Eskom's experimental wind farm at Klipheuwel is exploring the use of wind energy for bulk electricity-generation. Three different models were selected for Eskom to demonstrate and assess their different mechanical and electrical performances.

The Darling Wind Farm is a proposed bulk renewable energy IPP that involves the construction of a 5 MW wind farm in the Darling area of the Western Cape. The project partners have been able to successfully negotiate a power purchase agreement with the City of Cape Town for the purchase of the electricity generated by the wind farm. In addition,

the shareholders, CEF and the Darling Independent Power Producer, structured the shareholder and management agreements required to form the basis of the IPP company structure. Commissioning of the Darling National Demonstration Wind Farm is expected in 2005.

One of the activities of the GEF-funded South African Wind Energy Programme, which is funded by the GEF and supported through CaBEERE, is to quantify South Africa's commercial exploitable wind resources.

Moderate wind regimes, for example the large sparsely populated areas of the Karoo and Northern Cape, can be economically exploited in stand-alone or hybrid electricity-generation configurations with PV and/or diesel generator sets. A small local supply industry focusing on small stand-alone battery-charging systems already exists in the country.

### Hydro

A popular perception that the potential for hydropower in South Africa is very low, is often overstated. It has been shown in an assessment conducted by the Department of Minerals and Energy, the *Baseline Study on Hydropower in South Africa*, that there exists a significant potential for the development of all categories of hydropower in the short- and medium-term in specific areas of the country.

The Eastern Cape and KwaZulu-Natal are endowed with the best potential for the development of small, i.e. less than 10-MW hydropower plants. The advantages and attractiveness of these small hydropower plants are that they can either be stand-alone or in a hybrid combination with other renewable energy sources. Advantage can be derived from the association with other uses of water (e.g. water supply, irrigation, flood control, etc.), which are critical to the future economic and socio-economic development of South Africa.

The SAPP allows the free trading of electricity between SADC member countries, providing South Africa with access to the vast hydropower potential in the countries to the north, notably the significant potential in the Congo River (Inga Falls). At the same time, the countries to the north could benefit through access to the coal-fired power resources in

the south. Such an arrangement should stabilise the energy requirements of the region as a whole well into this century.

Exploitation of the vast hydropower resources will constitute a significant infusion of renewable energy resources into the energy economy of the region over the medium to long term. The Lesotho Highland Water Scheme has the capacity to contribute some 72 MW of hydroelectric power to the system in the short term. Global pressures regarding the environmental impact and displacement of settlements by huge storage dams will likely limit the exploitation of hydropower on a large scale.

Small-scale hydro generators (<10 MW) could be stand-alone or used in combination with other renewable energy and conventional technologies (hybrid systems) for power generation.

Irrespective of the size of installation, any hydropower development will require authorisation in terms of the National Water Act, 1998 (Act 36 of 1998).

## **Energy and the environment**

### **Energy and the global environment**

On a global scale, South Africa's contribution to GHG emissions is small. On a per-capita basis, however, it is well above global averages and that of other middle-income developing countries.

Furthermore, the economy is carbon-intensive, producing only US\$259 per ton of carbon dioxide emitted, as compared with US\$1 131 for South Korea, US\$484 for Mexico and US\$418 for Brazil.

### **Sources of greenhouse gas emissions**

The energy sector is a major source of GHG because of the heavy reliance on coal for electricity generation, the Sasol oil-from-coal process, and a variety of other indigenous energy uses such as household coal burning.

In addition, 57% of the coal-mining methane emissions can be attributed to these two uses of coal.

### **Energy and the national environment**

There is some contention regarding the polluting effects of the energy sector, particularly in the

Mpumalanga Highveld – the location of most of Eskom's coal-powered stations and the largest Sasol plants.

As is the case internationally, there is ongoing debate about the desirability of nuclear energy.

### **Energy and the household environment**

Coal is used by about 950 000 households country-wide. This brings with it indoor air-pollution problems, which have a serious health impact.

It has been found that some people's exposure, especially to particulate matter, can exceed World Health Organisation (WHO) standards (180 mg.m<sup>-3</sup>) by factors of six to seven during winter, and two to three in summer. A national programme has been established to introduce low-smoke alternatives into the townships.

Fuel wood is used by three million rural households as their primary energy source. Studies have shown that fuel-wood users are exposed to even higher levels of particulate emissions than coal users. In one study, exposure levels were found to exceed the WHO lowest-observed-effect level by 26 times.

The Department participates in the National Housing Interdepartmental Task Team and has contributed towards the development of norms and standards for solar-passive and thermally efficient housing design.

The Department is investigating the introduction of improved woodstoves and other alternatives, such as solar cookers and biogas, in an attempt to address these pollution problems.

More widespread is the use of paraffin by low-income households, rural as well as urban. Paraffin has, however, associated health and safety problems. The distribution of child-proof caps and the dissemination of information on the safe storage and use of paraffin are some of the measures being taken by the Department and other role-players to address the problem.

Apart from the Department of Minerals and Energy, the departments of Health, Environmental Affairs and Tourism, and Water Affairs and Forestry, are involved to a greater or lesser degree in the monitoring of and legislation on pollution.

## Geology

South Africa has a geological wonderland, which comprises 10 different and unique areas across the country.

### Barberton mountain land

The beautiful and rugged tract of country with some of the oldest rocks on Earth is situated in Mpumalanga. The renowned Barberton Greenstone Belt, the largest of its kind in South Africa, represents remnants of original crust, dated around 3 500 million years. The greenstone formations represent the earliest, clearly decipherable geological events on the Earth's surface. Silica-rich layers within the greenstone have revealed traces of a very early life form – minute blue-green algae.

The formations are surrounded by granites and gneisses more than 3 000 million years old.

Gold, iron ore, magnesite, talc, barite, chrysotile asbestos and verdite are mined in the area.

### Bushveld Complex and Escarpment

The Bushveld Complex extends over an area of 65 000 km<sup>2</sup> and reaches up to 8 km in thickness. It is by far the largest layered igneous intrusion in the world. It contains most of the world's resources of chromium, PGMs and vanadium. This mega-Complex was emplaced in a molten state about 2 060 million years ago into pre-existing sedimentary rocks, through several deep feeder zones.

The impressive igneous geology of the Bushveld Complex is best viewed in Mpumalanga, in the mountainous terrain around the Steelpoort Valley. In abundance here are the imposing Dwars River chromitite layers, the original platinum-bearing dunite pipes, the discovery site of the platinum-rich Merensky Reef, and extensive magnetite-ilmenite layers and pipes near Magnet Heights and Kennedy's Vale.

The Great Escarpment is one of South Africa's most scenic landscapes. This area features potholes (at Bourke's Luck), the Blyde River Canyon and the dolomite formation in which giant stromatolites bear witness to the 2 500 million-year-old fossilised remains of vast oxygen-producing algae growth.

### Drakensberg Escarpment and Golden Gate Highlands National Park

The main ramparts of the Drakensberg range, reaching heights of more than 3 000 m, lie in KwaZulu-Natal and on the Lesotho border. These precipitous mountains are the highest in southern Africa and provide the most dramatic scenery.

They are formed from outpourings of basaltic lava more than 1 500 m thick, covering the Clarens sandstones. Only a small remnant of the once-vast continental basalt field that covered much of the continent now remains, mostly in the highlands of Lesotho.

The northern area of the Drakensberg has been declared a World Heritage Site. More than 40% of all known San cave paintings in southern Africa are found here.

The Golden Gate Highlands National Park features spectacular sandstone bluffs and cliffs. The sandstone reflects a sandy desert environment that existed around 200 million years ago. Dinosaur fossils can still be found in the area.

### Karoo

The Karoo Supergroup covers most of South Africa and reaches a thickness of several thousand metres. The sedimentary rock sequence reveals an almost continuous record of deposition and life, from the end of the Carboniferous into the mid-Jurassic periods, between 300 and 180 million years ago.

Karoo rocks are internationally renowned for their wealth of continental fossils, and particularly for the fossils of mammal-like reptiles that show the transition from reptiles to early mammals, and for early dinosaur evolution.

During this long period of the history of the Earth, southern Africa was a lowland area in the centre of the Gondwana supercontinent.

Initially, the prehistoric Karoo was a place of vast glaciation, then a shallow inland sea, followed by huge rivers, lush flood plains and swampy deltas, ending in sandy desert and finally, vast outpourings of continental basaltic lava heralding the Gondwana break-up.

### **Diamond fields**

Kimberlite is the primary host-rock of diamonds and was first mined as weathered 'yellow ground' from the Kimberley mines, starting in 1871 at Colesberg koppie, now the site of the Big Hole of Kimberley.

At increasing depths, less-weathered 'blue ground' continued to yield diamonds.

The discovery of kimberlite-hosted diamonds was a key event in South Africa's economic and social development, and paved the way for the later development of the Witwatersrand goldfields.

Kimberlite originates as magma from very deep below the surface, and typically occurs as small volcanic pipes and craters at the surface. Included within solidified kimberlites are fragments of deep-seated rocks and minerals, including rare diamonds of various sizes.

The Orange and Vaal rivers' alluvial diamond fields, and the rich West Coast marine diamond deposits, all originated by erosion from primary kimberlite pipes.

### **Meteorite impact sites**

Impacts by large meteoritic projectiles played a major role in shaping the surface of the Earth.

One such site is the Vredefort Domes, the oldest and largest impact structure known on Earth.

It is located some 110 km south-west of Johannesburg, in the vicinity of Parys and Vredefort in the Free State and North West.

This spectacular and complex geological feature, measuring 70 km across, has recently been proved to be the remnant of the original catastrophic impact by a large meteorite or asteroid, some 2 000 million years ago. The original impact crater has long since eroded.

The Vredefort structure consists of a 50-km wide core zone made up of granitic rocks, surrounded by the ring-like collar zone of younger bedded formations. Younger Karoo sediments cover the structure in the south-east.

### **Pilanesberg**

The Pilanesberg Complex and National Park, located some 120 km north-west of Johannesburg in North West, is a major scientific attraction which includes a number of unique geological sites.

The Complex consists of an almost perfectly circular, dissected mountain massif some 25 km in diameter, making it the third-largest alkaline ring complex in the world.

The geology reflects the roots of an ancient volcano that erupted around 1 500 million years ago.

The remains of ancient lava flows and volcanic breccias can be seen.

The dominant feature of the Complex is the concentric cone sheets formed by resurgent magma that intruded ring fractures, created during the collapse of the volcano. There are old mining sites for fluorite and dimension stone, and a non-diamond-bearing kimberlite pipe in the region.

### **Cradle of Humankind (Sterkfontein)**

Located mainly in Gauteng, this World Heritage Site extends from the Witwatersrand in the south to the Magaliesberg in the north, and is considered to be of universal value because of the outstanding richness of the fossil hominid (family of man) cave sites.

The Sterkfontein area near Krugersdorp stands supreme as the most prolific and accessible fossil hominid site on Earth. It comprises several scientifically important cave locations, including Sterkfontein, Swartkrans, Drimolen, Kromdraai, Gladysvale and Plover's Lake, all of which have produced a wealth of material crucial to paleo-anthropological research.

### **Table Mountain and the Cape Peninsula**

Table Mountain is arguably South Africa's best known and most spectacular geological site, being made up of five major rock formations.

The earliest of these are the deformed slates of the Malmesbury Group which formed between 560 and 700 million years ago.

Coarse-grained Cape Granite intruded around 540 million years ago.

The Table Mountain Group, deposited from 450 million years ago, consists of basal, reddish mudstone and sandstone, very well exposed along Chapman's Peak Drive. Overlying this is the light-coloured sandstone that makes up the higher

mountains and major cliff faces of the Cape Peninsula, as far south as Cape Point.

Much younger sandy formations make up the Cape Flats and other low-lying areas.

The Table Mountain Group continues further inland across False Bay in the strongly deformed Cape Fold Belt.

### **Witwatersrand**

The geology and gold mines of the 'Ridge of White Waters' are world-famous. Nearly half of all the gold ever mined has come from the extensive Witwaters-rand conglomerate reefs that were discovered in 1886, not far from the city centre of Johannesburg.

The Witwatersrand is the greatest goldfield of all time, with more than 48 000 t of gold having been produced from seven major goldfields distributed in a crescent-like shape across the 350-km long basin, from Welkom in the Free State in the southwest, to Evander in the east.

The geology of the region can be seen at many excellent outcrops in the suburbs of Johannesburg. The sequence is divided into a lower shale-rich group and an upper sandstone-rich group, the latter containing the important gold-bearing quartz-pebble conglomerates. These 'gold reefs' were formed from gravels transported into the basin and reworked 2 750 million years ago. The gold and uranium originated from a rich source in the hinterland.

## Acknowledgements

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