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Minerals, energy and geology

The aim of the Department of Minerals and Energy is to formulate and implement an overall minerals and energy policy to ensure the optimum use of minerals and energy resources.

The department's Electricity and Nuclear Branch is responsible for electricity and nuclear-energy affairs. The Hydrocarbons and Energy Planning Branch is responsible for coal, gas, liquid fuels, energy efficiency, renewable energy, designated national authority and energy planning, energy data and statistics, the roll-out of integrated energy centres and the establishment of a national energy database.

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

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

The Mineral Regulation Branch regulates the mining and minerals industry to achieve transformation and to contribute to sustainable development.

Policy

The Minerals and Petroleum Resources Development Act (MPRDA), 2002 (Act 28 of 2002), 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 its application in terms of the requirements of the MPRDA, 2002, for the conversion of all the old-order rights into new rights.

Although the charter has produced a growing number of Black Economic Empowerment (BEE) deals and joint ventures, the quality of deals and how broad-based they are has raised concern.

It is still too early to assess the impact of the Act on achieving representative management in the sector. Although over 70% of the mining industry's labour force is black, less than 5% of managerial



positions are held by black people. The effectiveness of the regulatory measures will be assessed by 2009, when all mining companies are expected to have 40% of managerial positions held by HDIs.

The provisions of the MPRDA, 2002 have necessitated the establishment of the National Mining Promotion System (NMPS). This online system allows the department to improve mineral licensing administration, investment promotion and the registration of rights. The NMPS enables the department to improve on turnaround time when processing applications, and to maintain proper management and administration of mineral-related rights and permits.

Between the promulgation of the MPRDA, 2002 and June 2006, the department had received 7 500 applications for all types of rights, which was a tenfold increase over the number of applications that were received annually during apartheid. Over 80% of these applications were for new prospecting rights.

In 2005/06, the department received 6 785 mining-licence applications, of which 957 were rejected mainly for being incomplete, 191 were withdrawn, 861 refused for not complying with the Act, and 912 issued.

The Mining Titles Registration Amendment Act, 2003 (Act 24 of 2003), was promulgated in

November 2003. The purpose of the 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). This transfers the functions relating to the registration of minerals rights from the ambit of the Act into the duties and functions of the Director-General of the Department of Minerals and Energy.

The Diamonds Amendment Act, 2005 (Act 29 of 2005), introduces a new era in the regulation of the diamond trade in South Africa by combining the regulation of the diamond trade with the precious metals trade through the Diamond and Precious Metals Regulator. This regulator will replace the South African Diamond Board, which handled both promotion and regulation. These functions are now to be split. The regulator will focus only on the administration of the law, while the newly established State Diamond Trader will have the promotion of the diamond industry as one of its functions.

The trader will also be responsible for acquiring and supplying rough diamonds to the industry and for promoting research and development. A diamond-export centre will control diamond exports. For diamonds and precious metals, local companies will now be able to access the raw

material and rough diamonds, which up to now have been sold on international markets predominately. Consequently, South Africa's capabilities in the cutting and polishing industry, as well as in the jewellery manufacturing industry, are expected to expand, creating jobs.

The Precious Metals Act, 2005 (Act 37 of 2005), provides for the acquisition of smelting, refining, using and disposing of precious metals, with the emphasis on increased value addition.

Mine environmental management

Mine environmental management, which forms an integral part of the management of mineral and petroleum resources, focuses on:

- Strengthening enforcement to prevent mining legacies from occurring. This relates to the effective implementation of the MPRDA, 2002 and other short- and long-term strategies to strengthen environmental enforcement.
- Identifying mine-pollution 'hot spots' and implementing regional closure strategies to direct operational mines in addressing and managing pollution and mining waste within these areas.
- Rehabilitating abandoned and ownerless mines in accordance with a priority ranking system and a dedicated database.

Some R120 million has been allocated over 2005/06 and 2006/07 for the rehabilitation of these mines, with abandoned and ownerless asbestos dump sites being the first priority. Some R18 million has been set aside for the rehabilitation of abandoned uranium mines in the Karoo and Free State.

The Department of Minerals and Energy has allocated R32 million to water-pumping subsidies, in response to ongoing problems with mine water, especially on the Witwatersrand.

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.

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 regarding 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.

International processes and structures such as the African Mining Partnership (AMP) have been established to champion, among other things, 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 was instrumental in establishing the Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development.

The 14th session of the United Nations (UN) Commission on Sustainable Development (CSD) held in New York in May 2006 focused on the central role that energy has in furthering sustainable development. It gave developing countries such as South Africa an opportunity to identify barriers to sustainable energy development, and to propose key policies and measures that can redress these obstacles to sustained economic growth, social upliftment and environmental consideration. It intended to assist in implementing the JPI.

Sustainable development on the African continent

In support of the implementation of mining-related Nepad issues, the department played an important role in conceptualising the AMP, a mining ministers' partnership that was launched in 2004 to drive the minerals and mining agenda of Nepad.

The third AMP met in Cape Town in February 2006. The projects assigned to countries to ensure that they contribute to growing Africa's economy by using minerals, included a partnership between South Africa and Mali involving the exchange of training programmes in the area of beneficiation.

The Intergovernmental Memorandum of Understanding (MoU) on the Western Power Corridor Project (Westcor) was signed in October 2004. Westcor is a Nepad flagship programme intended to pilot hydroelectric energy of the Inga rapids site in the Democratic Republic of Congo (DRC). It will ensure security of supply in the Southern African

Development Community (SADC). The participating utilities are those of Namibia, South Africa, the DRC, Botswana and Angola. A joint-venture company has been formed to initiate studies determining the viability of the project and to build, own, and operate the infrastructure.

Black Economic Empowerment

The Department of Minerals and Energy continues to support BEE suppliers in pursuance of the Liquid and Fuels Charter. On 30 November 2004, the department and individual members of the Southern African Petroleum Industry Association signed an MoU aimed at the creation of the Supplier Development Agency. The agency opened its doors for trading on 1 April 2005.

The agency's primary objectives are to source potential BEE suppliers, to accredit the suppliers to combat fronting, to develop suppliers to meet the performance levels of the industry, and to source opportunities for BEE suppliers from industry.

To accurately assess the level of compliance with targets as set out in the Liquid Fuels Charter, the Department of Minerals and Energy commissioned Empowerdex to perform a five-year review. This revealed that the level of compliance was not as high as expected and showed that only 3,8% of procurement spending, or about R103 billion, went to BEE companies.

By February 2006, the liquid fuels industry employed 8 817 people. Of these, 68% were black, which was an increase of 3% since 2003.

Mining industry

Preliminary figures for 2005 indicate that South Africa's mining contributed R94,3 billion or 6,9% gross value added, which is an increase of R6,83 billion from the previous year. The trend where foreign revenue earnings are dominated by platinum-group metals (PGMs) at US\$3,8 billion, followed by gold at US\$5,3 billion, also continued in 2005.

However, the gold sector has been declining due to the challenges of ageing infrastructure in deep mines. The industry faces challenges of commodity-price cycles and is also affected by the currency fluctuations and business models that are not aligned with current rand value.

The Department of Minerals and Energy, in collaboration with its partners, labour and business, is evolving a strategy to manage the decline of the sector and the impact on workers.

South Africa produces 14% of the world's gold, and has 41% of the world's known reserves. It is estimated that 21 000 tons (t) of undeveloped resources, about one-fifth of the world's unmined gold, still remains. These ores are increasingly difficult to exploit due to the great depths where they are situated and their fairly low-grade quality.

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 of 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.

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. Government has dedicated significant time and resources to engaging the Richtersveld community in developing a comprehensive and beneficial resolution.

A memorandum of agreement was signed with the community in February 2006 and the subsequent conclusion of a settlement with the community was expected to accelerate the recapitalisation of Alexkor, enabling the mine to implement its short-term turnaround plan and drive its exploration and expansion programme. In the meantime, the Department of Public Enterprises was proceeding with transferring community services such as the hospital, school, airport and other non-core services managed by Alexkor to the relevant authorities. A consultant was appointed to support the establishment of a municipality.

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.

According to the Labour Force Survey, in the formal sector, a downturn in the mining industry in

recent years is reflected in the falling share of mining in total; employment went from 7,8% in September to 5,1% in September 2005.

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 MHSI, established in terms of the Mine Health and Safety Act (MHSA), 1996 (Act 29 of 1996), is responsible for protecting the health and safety of persons working at mines or affected by mining activities.

The activities of the MHSI are unequivocally focused on achieving a safer and healthier mining industry for all.

The MHSI works closely with industry and worker unions to reduce the incidence of mine accidents, with stakeholders committing themselves to continuously reducing fatalities by at least 20% a year. The inspectorate is also pursuing a strategy to eliminate silicosis and noise-induced hearing loss or occupational deafness by 2013, and to reduce the social costs of diseases and injuries to vulnerable communities, in particular. Overall, the 2005 accident rate was the lowest recorded in the history of South African mining, but the department aims to reduce it further and achieve parity with international rates by 2013.

In the 10 years since the MHSA, 1996 was introduced, there has been a significant decrease in fatalities at mines. In 1995, there were 533 fatalities and 7 717 injuries. By the end of 2005, fatalities stood at 202 and injuries at 3 961. The fatality rate for mines dropped by 16% from 0,25 fatalities per million hours worked in 2004, to 0,21 in 2005. The injury rate decreased by 8% in the same period.

The Mine Health and Safety Council advises the Minister of Minerals and Energy on the continued development of a revised regulatory framework for the industry. Projects aimed at raising awareness on the prevention, treatment and care of HIV and AIDS in the mining industry include the:

- Powerbelt Project, which focuses on coal-mining areas
- Lesedi Project in Virginia, Free State

- Lechabile Project in Welkom, Free State
 - Bambisanani Project in Lusikisiki, Eastern Cape
 - Carletonville Home-Based Care Project, Gauteng.
- The Chief Inspector of Mines also proposed a strategy for dealing with deaths associated with HIV and AIDS, following a non-life-threatening mine accident.

The Safety in Mines Research Advisory Committee has a programme to overcome barriers to improved occupational health and safety performance. The programme comprises:

- cultural change
- rockfalls
- rockbursts
- explosions and fires
- machinery and transport systems
- airborne pollutants
- physical hazards (noise, temperature, radiation, etc.)
- occupational diseases (the effect of HIV and AIDS on tuberculosis and silicosis)
- special projects (surveys for quantifying risk prevalence).

Mine Qualifications Authority (MQA)

The MQA aims 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 MQA is responsible for:

- developing and monitoring the implementation of a sector skills plan
- registering skills-development facilitators at workplaces within the sector
- approving work-skills plans and annual training reports of companies in the sector
- developing unit standards and qualifications
- maintaining the quality of standards, qualifications and learning provision in the sector
- establishing, registering, administering and promoting learnerships

- administering existing apprenticeship systems
- administering and disbursing skills-development levies.

The MQA has introduced several initiatives to address skills shortages that specifically aim to support transformation across the mining and minerals sector. Two strategic documents support BEE in the mining industry. The Service Level Agreement signed with the Department of Labour commits to targets set by the National Skills Development Strategy that are underpinned by equity principles aimed at accelerating Broad-Based BEE and employment equity.

Therefore, of all people trained, 85% should be black, 54% women and 4% people with disabilities.

The second strategic document that supports BEE in the mining industry is the MQA Mining Charter Support Strategy. In support of the Mining Charter, the MQA has introduced the Executive Preparation Programme; the Graduate Development Programme; a bursary scheme, including support for undergraduate practical training; the Universities Employment Equity Project; and support for small-scale miners. The MQA also supports small, medium and micro enterprises in the sector by means of grants for training in small-scale mining, mineral beneficiation, jewellery manufacturing and diamond processing.

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. It covers 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 Limited, the world's largest gold refinery
- the Nuclear Fuels Corporation (Nufcor)
- Colliery Technical Services, which includes the Colliery Training College
- Rescue Drilling Unit
- Collieries Environmental Control Services
- the Council for Scientific and Industrial Research's Mining Technology Division (Miningtek).

South Africa's mineral reserves, 2005

Commodity	Unit	Reserves	%	World ranking
Alumino-silicates	Kt	51	37,4	1
Antimony	t	250	6,4	3
Chrome ore	Kt	5 500	72,4	1
Coal	Mt	28 559	6,0	7
Copper	Kt	13	1,4	14
Fluorspar	Mt	80	16,7	2
Gold	t	36 000	40,1	1
Iron ore	Mt	1 500	0,9	9
Lead	Mt	3 000	2,0	
Manganese ore	Kt	4 000	80,0	1
Phosphate rock	Kt	2 500	5,0	n/a
Platinum-group metals	Kg	70 000	87,7	1
Silver	t	10	1,8	9
Titanium minerals	Kt	244	29,8	2
Uranium	t	298	9,6	4
Vanadium	Kt	12 000	27,0	1
Vermiculite	Kt	80	40,0	1
Zinc metal	Kt	15	3,3	6
Zirconium minerals	Kt	14	19,4	2

Mt=megaton, Kt=kiloton, t=ton, n/a=not available, Kg=Kilogram

Source: Minerals Bureau

Junior and small-scale mining

The Department of Minerals and Energy is committed to ensuring that the small-scale mining sector becomes sustainable.

Numerous small-scale mining projects have received technical assistance to enable them to comply with legislation, or financial aid to help them get started. In 2005, the department created the Small-Scale Mining Board with the mandate of finding and implementing solutions to overcome identified limitations within the small-scale mining sector.

The board will give priority to quality projects that will serve the poor and contribute to economic development.

The small-scale mining sector includes:

- artisanal or subsistence mining operations (new entrants)
- suboptimal formal mining operations
- entrepreneurs with start-up capital.

Within the department, the Directorate: Small-Scale Mining helps aspiring small-scale miners:

- to establish a legal entity
- to identify mineral deposits
- with environmental impact assessments (EIAs)
- with legal and contractual arrangements and mineral rights
- to calculate a reserve estimation of the selected deposits
- to carry out mining-feasibility studies
- to perform market studies
- to develop their mining equipment.

The Small-Scale Mining Board co-ordinates a substantial amount of expert capacity and experience, and specialises in planning and developing viable mining projects through their pre-feasibility stages.

The National Small-Scale Mining Development Framework also assists 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 also 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, which are legalised and converted into sustainable operations
- undercapitalised operations which require expansion or optimisation
- first-time entrepreneurs interested in greenfield projects.

The South African Small-Scale Mining Chamber (SASSMC) was launched in July 2005 in Kimberley, Northern Cape.

The SASSMC represents the interests of small-scale miners nationally. Its objectives include positioning small-scale mining member companies to use available mining opportunities in and beyond South Africa's borders. It also aims to provide a model for small-scale mining that can be used as a basis to link up with the SADC and the AMP.

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 96% 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, chrome and vanadium – 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, Free State, Limpopo and the Eastern Cape.
- Copper, phosphate, titanium, iron, vermiculite and zirconium are found in the Phalaborwa Igneous Complex in Limpopo.

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

- manganese
- chromium
- PGMs

- gold
- alumino-silicates
- vanadium.

Due to the small domestic market for most commodities, South Africa's mineral industry is export-orientated. Alumino-silicates contribute 44%, ferrochromium 54%, chrome ore 57%, manganese ore 20,2% and ferromanganese 15,9% while vanadium and antimony also contribute significantly towards the export market.

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 its 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.

South Africa's total sales of primary minerals increased by 6,5% to R125,2 billion in 2004. Total processed mineral sales increased by 27% from R27,8 billion in 2003 to R35,3 billion in 2004.

The combined total for primary and processed mineral sales is estimated to have increased by 10,3% from R145,5 billion in 2003 to R160,5 billion in 2004.

Domestic primary mineral sales revenue increased in 2004 by 3,2% to R89,6 billion.

The value of exports of primary minerals in 2004 increased by 3,2% to R89,6 billion.

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

Gold

World demand for gold increased by 4,9% to 4 036 t in 2005. The average gold price traded at US\$445/oz.

World mine supply increased by 49 t to 2 519 t, but South African gold production fell by 13,4% to 294,8 t in 2005. Provisional data for 2005 indicates that total gold sales decreased by 14,9% to US\$3,87 billion.

Coal

In 2005, South African mines produced 245 million tons (Mt) of coal. Of this figure, 174 Mt was used

locally, at a value of R14,69 billion, with export sales totalling 71,4 Mt at a value of R21,17 billion. South Africa has around 28,6 billion tons of recoverable coal reserves, making it the seventh-largest holder of coal reserves in the world.

Platinum-group metals

South Africa's PGM production increased by 9,6% to 302,9 t in 2005, while PGM revenue increased by 16,8% to US\$6,04 billion. The average platinum price for 2005 was 6% higher at US\$897/oz, while the average palladium price was 12,6% lower at US\$201/oz. World demand for platinum increased by 1,8% to 208,7 t in 2005.

South Africa's mineral production, 2005

Commodity	Unit	Reserves	%	World ranking
Aluminium	Kt	866	2,9	10
Alumino-silicates	Kt	235	38,0	1
Antimony	t	4 967	3,2	3
Chrome ore	Kt	7 645	44,5	
Coal	Mt	243	5,2	5
Copper	Kt	103	0,8	18
Fluorspar	Mt	365	5,0	
Gold	t	341	13,8	1
Iron ore	Mt	39,3	3,3	
Lead	Mt	38	1,3	13
Manganese ore	Kt	4 282	14,8	
Nickel	Kt	40		
Phosphate rock	Kt	2 735	1,9	
Platinum-group metals	Kg	286 157	57,8	1
Silver	t	72	0,4	
Titanium minerals	Kt	–	–	–
Uranium	t	887	2,1	4
Vanadium	Kt	23	48,0	1
Vermiculite	Kt	197	41,0	1
Zinc metal	Kt	32	0,4	22
Zirconium minerals	Kt	–	–	–

Mt=megaton, Kt=kiloton, t=ton, n/a=not available, Kg=Kilogram

Source: Minerals Bureau

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 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 10,3% annually. Demand depends on the fortune of the world's steel and stainless steel industries.

Export earnings from ferrous minerals increased by 70,45% from R4,84 billion in 2004 to R8,25 billion in 2005, despite the fact that higher dollar earnings were severely discounted by a much higher average Rand/Dollar exchange rate ratio for 2005. Higher prices also affected total ferrous sales, which rose by 45,2% to R11,63 billion.

Industrial minerals

This sector comprises a wide variety of mineral products with local sales accounting for over 85% of revenue. In dollar terms, domestic total sales increased by 19% to US\$925 million. In rand terms, local sales increased by 17% to R6 billion and export sales decreased by 5% to R1 billion.

During 2005, 83% of local sales comprised aggregate and sand (38%), limestone and lime (22%), phosphate-rock concentrate (data withheld) and sulphur (4%).

Exports were dominated by dimension stone (26%), vermiculite (19%), andalusite (19%), fluorspar (22%) 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.

International prices of processed minerals surged strongly during 2004 on the back of

vigorous growth in demand in China and the East. As a result, export sales earnings were at an all-time high of US\$4,096 billion in 2004, and up 48% from US\$2,762 billion in 2003.

Other minerals

This sector is dominated by diamonds, with support from hydrocarbon fuel, uranium oxide and silver. Revenue from these minerals increased by 6,5% to R125,2 billion in 2004.

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

Energy

The Department of Minerals and Energy's Energy Policy is based on the following key objectives:

- attaining universal access to energy by 2014
- providing accessible, affordable and reliable energy, especially to the poor
- diversifying primary energy sources and reducing dependency on coal
- good governance, which must also facilitate and encourage private-sector investments in the energy sector
- environmentally responsible energy provision.

Estimates suggest that R107 billion will be needed between 2005 and 2009 to meet the country's growing energy needs. Eskom will invest R84 billion over the next five years. The balance of R23 billion is reserved for independent power producer (IPP) entrants.

By May 2005, the department was in the process of procuring 1 000 megawatts (MW) through IPPs, which are expected to be commissioned in 2008.

The refurbishment of three power stations – Camden in Ermelo, Grootvlei in Balfour, and Komati in Middelburg – will result in an additional 3 800 MW to the system.

Eskom is expected to spend about R12 billion (nominal rand) on recommissioning these stations, representing about 40% of the cost of a new station. About 10% of the costs will go towards improving environmental performance such as particulate emissions and water controls.

At least 36 000 jobs are expected to be created, directly and indirectly, during both construction and operational phase activities.

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 MW. Total liquid-fuel 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.

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

Coal, as the major indigenous energy resource, is relied on 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 consistently engaging members of the Organisation of Petroleum Exporting Countries through diplomatic channels to increase production.

Energy efficiency

The Energy Efficiency Strategy, which was approved in March 2005, sets a national target for energy-efficiency improvement of 12% by 2015.

All state-owned enterprises have been requested to make energy efficiency a part of their shareholders' compacts. In addition, large companies have joined forces with the Department of Minerals and Energy and Eskom by signing an energy-efficiency accord, committing themselves to targets contained in the department's strategy.

To assist households to be more energy-efficient, the department initiated an appliance-labelling campaign, starting with refrigerators. Labels on household appliances inform consumers how energy-efficient their appliances are. Labels will also be introduced for vehicles to indicate the fuel consumption of the vehicle as well as its carbon dioxide emissions.

The department, in collaboration with the Department of Public Works and Eskom, is

retrofitting government buildings to make them more energy-efficient. In 2006, the South African National Standards 204 for commercial buildings were being finalised. The department is in the process of establishing the National Energy Efficiency Agency as a subsidiary of the Central Energy Fund (CEF) to, among other things, oversee the implementation of energy efficiency and demand-side management projects, as well as the measuring and verification of these projects.

The CEF houses the South African National Energy Research Institute, which is designed to generate new ideas to develop practical guidelines for taking advantage of natural resources of clean and renewable energy.

Energy statistics

Detailed, complete, timely and reliable statistics are essential to monitor the energy situation in South Africa. In addition, energy statistics on supply, trade, stocks, transformation and demand are the basis for any sound policy decision.

The Department of Minerals and Energy, in collaboration with Statistics South Africa, is responsible for providing energy data and statistics. It has embarked on a programme to strengthen the expertise and experience of the department's staff to be able to collect, verify, analyse and publish energy statistics. In addition, it intends to reduce the backlog in the provision of energy balances to one year.

Energy statistics are made available through publications such as the *Energy Digest*, and *Energy Price Report*, as well as in electronic format and on the department's website.

The department, through the Energy Bill, intends to make the provision of energy data mandatory.

Integrated Energy Planning (IEP)

IEP involves estimating how much energy all consumers (e.g. industry or households) will need in future to deliver certain services, and then identifying a mix of appropriate sources and forms of energy to meet these needs in the most efficient and socially beneficial manner.

In terms of the *Energy White Paper, 1988*, the department will ensure that an integrated resource-planning approach is adopted for large investment decisions by energy suppliers and service-providers, in terms of which comprehensive

evaluations of the economic, social and environmental implications of all feasible supply- and demand-side investments will have to be undertaken.

The Department of Minerals and Energy published IEP1 in 2003, and is expected to publish IEP2 in 2007.

Integrated energy centres (IECs)

One of the many approaches that the department has taken to address energy poverty is IECs – one-stop energy shops owned and operated by a community co-operative and organised as a community project.

IECs provide a bouquet of energy services; making energy easily available, promoting awareness of the different energy sources and services, providing capacity-building, and promoting local empowerment and development through energy provision.

Each local IEC is linked with the Integrated Development Plan (IDP) of the particular area, which is implemented through the Integrated Sustainable Rural Development Strategy. This results in the provision of wider energy choices being integrated with other projects like supplying water, and building schools and clinics. The community owns this process through a community-based co-operative, and dictates how their needs are met, especially as they were involved in developing the IDPs.

By mid-2006, five IECs had been established in Greytown, KwaZulu-Natal; Matatiele, Eastern Cape; Kgalagadi and Moshaweng both in Kuruman, Northern Cape; and Mutale in Limpopo.

The Minister of Minerals and Energy has approved the IEC Strategy and action plan that will facilitate the roll-out of sustainable IECs in the poverty nodal areas as well as in district and local municipalities.

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 obtained from coal (18%), illuminating paraffin (7%) and a small amount from liquid petroleum gas (LPG).

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 households having access to electricity.

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 of the world's electricity production.

About 75% of South Africa's primary energy needs are provided by coal. This is unlikely to change significantly in the next two decades, due to the relative lack of suitable alternatives to coal as an energy source.

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 27% of South Africa's production is exported internationally, mainly through the Richards Bay Coal Terminal, making South Africa the fourth-largest coal-exporting country in the world.

South Africa's coal is obtained 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 2005. Of these, a relatively small number of large-scale producers supply coal primarily to electricity and synthetic fuel producers. About 47% of South African coal mining is done underground and about 53% is produced by opencast methods.

The coal-mining industry is highly concentrated, with six companies, namely Ingwe Collieries (BHP Billiton), Anglo Coal, Sasol Mining, Eyesizwe Coal, Kumba Coal and Xstrata Coal accounting for 91% of the saleable coal production. The 11-largest mines account for 70% of the output.

South African coal for local electricity production is among the cheapest in the world. The

In May 2006, the gold price broke through the crucial US\$700 a troy ounce level for the first time since 1980.

Platinum also reached a new all-time high and was up nearly 4%, trading at US\$1,237 an ounce.

beneficiation of coal, particularly for export, results in more than 65 Mt of coal discards being produced annually.

The remainder of South Africa's coal production feeds the various local industries. About 110 Mt is used for electricity generation, 41 Mt for petrochemical industries (Sasol), 8 Mt for general industry, 7 Mt for the metallurgical industry, and 7 Mt is purchased by coal merchants and sold locally or exported.

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

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

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

Environmental concerns pose the main challenge to coal as an energy source. Not only does the burning of coal cause air pollution, but the mining activities to extract coal also affect the environment negatively. The department and the coal-mining industry are therefore fostering the introduction of clean coal technologies into the South African arena.

The department is giving priority to rolling out the Basa Njengo Magogo Programme that entails the top-down ignition of coal fire, which has been shown to reduce smoke by 80% to 90% in laboratory test conditions, and means that less coal is burnt and less carbon dioxide emitted.

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). These Acts are administered by the Department of Minerals and Energy; while part of the Hazardous Substances Act, 1973 (Act 15 of 1973), related to groups III and

IV of hazardous substances, is administered by the Department of Health.

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

- The Department of Minerals and Energy, which plays a leading governance role regarding 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, which undertakes and promotes research and development in the fields of nuclear energy, radiation sciences and technology, medical-isotope manufacturing, nuclear liabilities management, waste management and decommissioning. Necsa's reactor-produced radioisotopes are exported to more than 50 countries.
- The NNR, which oversees safety regulation of nuclear installations at Necsa's Pelindaba site, 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), which issues licences for group III hazardous substances (electronic-product generating X-rays, other ionising beams, electrons, neutrons or other particle radiation or non-ionising radiation) and group IV hazardous substances (radioactive material outside a nuclear installation, 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, which is responsible for electricity generation. It is government-owned through the public entity, Eskom, which reports to the Minister of Public Enterprises.
- iThemba Laboratories, which is responsible for medical isotopes and medical applications. This public entity falls under the Department of Science and Technology.
- Nufcor, which 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 Necsas's direct commercial sales of about R300 million per year.

Liquid fuels

The liquid-fuels industry was licensed for the first time in 2005. The objectives of the licensing framework as detailed in the Petroleum Products Amendment Act, 2003 (Act 58 of 2003), include:

- promoting an efficient manufacturing, wholesaling and retailing petroleum industry
- facilitating an environment conducive to efficient and commercially justifiable investment
- promoting the advancement of HDIs
- creating employment opportunities and small businesses in the petroleum sector.

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. South Africa imports about 60% of its crude oil requirements.

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.

PetroSA is responsible for exploring and exploiting oil and natural gas, as well as producing and marketing synthetic fuels produced from offshore gas at the world's largest commercial gas-to-liquids plant in Mossel Bay, in the Western Cape.

Sasol

Sasol operates the world's only coal-based synthetic fuels facility, producing LPG from low-grade coal. Sasol mines coal and converts it into synthetic fuels and chemicals through proprietary Fischer-Tropsch technologies. The company also has chemical manufacturing and marketing operations in Europe, Asia and the Americas. Its larger chemical portfolios include polymers,

solvents, olefins and surfactants and their intermediates, waxes, phenolics and nitrogenous products.

Sasol produces crude oil in offshore Gabon, refines crude oil into liquid fuels in South Africa, and retails liquid fuels and lubricants through a growing network of retail centres and service stations. In the first quarter of 2004, Sasol started supplying Mozambican natural gas to customers and to its petrochemical plants in South Africa. The company is also developing two gas-to-liquid fuel joint ventures that will incorporate the proprietary Sasol Slurry Phase Distillate Process.

Sasol's focus is on the manufacturing, refining and marketing of automotive and industrial fuels and oils, with a growing interest in gas. Its entry into hydrogen- and methane-rich gas production and exploration has extended into southern and West Africa.

In industry, Sasol provides premium fuels and lubricants that meet or exceed stringent specifications. It also produces jet fuel, fuel alcohol and illuminating kerosene.

Sasol is a signatory of Responsible Care, a worldwide initiative that strives to improve performance in safety, health and the environment.

Central Energy Fund

The CEF is involved in the search for appropriate energy solutions to meet the future energy needs of South Africa, the SADC and the sub-Saharan African region. This includes oil, gas, electrical power, solar energy, low-smoke fuels, biomass, wind and renewable energy sources. The CEF also manages the operation and development of the oil and gas assets and operations of the South African Government.

The CEF, through its integrated oil company subsidiary, PetroSA, is involved in exploration for oil and gas onshore and offshore in South Africa and the rest of Africa. It is also involved in the production of environmentally friendly petroleum fuels and petrochemical products from gas and condensate at its synfuels refinery outside Mossel Bay, and the management of oil-storage facilities. The Strategic Fuel Fund manages South Africa's strategic crude oil reserves.

The CEF has established the Energy Development Corporation (EDC) to pursue commercially viable investments in renewable

energy (except for natural oil and other already commercialised and developed energy technologies in southern Africa). The EDC's focus is on niche areas, and commercial and development projects that catalyse the renewable energy sector and social projects that benefit previously disadvantaged communities.

CEF subsidiary Oil Pollution Control SA provides oil-prevention control and clean-up services, mainly in South African ports and coastal areas. CEF subsidiary Petroleum Agency South Africa (Pasa) manages the promotion and licensing of gas exploration, development and production in South Africa and the coastal areas offshore as part of creating a viable upstream oil industry in South Africa.

CEF subsidiary iGas is the official agent of the South African Government for the development of the hydrocarbon gas industry, comprising liquified natural gas and LPG in South Africa.

Indigenous oil and gas resources and production

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

Government is committed to making it more affordable for cooking and heating to reduce the need for large investments in power generation.

Pasa has been successful in further encouraging international exploration companies to evaluate the country's oil and gas opportunities.

The EM gas-field complex off Mossel Bay started production in the third quarter of 2000. It 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 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 first three years.

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

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

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 to promote local refinery utilisation.

When overproduction occurs, export permits are required and generally granted, provided that the needs of both South Africa and other Southern African Customs Union members 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 LPG, 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 5% of net energy consumption, while LPG accounted for about 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 used 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.

Petronet owns and operates a gas pipeline, known as the Lily Line. It 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 LPG/air pipe network in Port Elizabeth. A privately owned company in Port Elizabeth distributes a small amount of LPG/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.

In May 2006, Eskom announced a R1,5-billion refurbishment of the Kriel Power Station in Mpumalanga. The project is set to give the station another 25 years of reliable and safe operation.

The upgrade will include the world's largest control and instrumentation refurbishment to be carried out in a fossil utility, extending the lifespan of the power station to 2028.

Cross-border gas trade agreement

To facilitate the movement of gas across international borders, South Africa signed a cross-border gas trade agreement with Mozambique and Namibia.

The construction of the 805 km-long Mozambique-to-South Africa gas-transmission pipeline was completed in March 2004.

Since the arrival of natural gas from Mozambique in 2004, the contribution of natural gas to the primary energy supply has risen from 1,5% to 3,3% (2005). This figure is expected to rise to 4,3% when the Mozambique-South Africa gas-transmission pipeline reaches maximum capacity.

By mid-2006, the South Africa/Namibia Gas Commission was addressing harnessing the natural gas reserves off the countries' coasts.

Electricity

South Africa supplies two-thirds of Africa's electricity and is one of the four cheapest electricity producers in the world. Almost 90% of South Africa's electricity is generated in coal-fired power stations. Koeberg, a large nuclear station near Cape Town, provides about 5% of capacity. A further 5% is provided by hydroelectric and pumped storage schemes.

In South Africa there are few, if any, new economic hydro sites that could be developed to deliver significant amounts of power. 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.

Eskom developed a robust strategy in 2004/05 in line with government's national climate change response strategy. In 2005/06, the roll-out of the strategy was prioritised. As part of the strategy, Eskom reiterated the aim of reducing the percentage of coal in the primary energy mix by 10% by 2012. This goal was first expressed at the WSSD in 2002 and was reconfirmed at the National Climate Change Conference hosted by the Department of Environmental Affairs and Tourism in October 2005.

In global terms, the utility is among the top 11 in generating capacity, among the top seven in terms of sales, and has one of the world's biggest dry-cooled power stations, Matimba Power Station.

Electricity, as a key strategic economic sector, underpins government's growth and development

objectives. The Department of Minerals and Energy has several policies in place to ensure an adequate supply of electricity-generation capacity and that the distribution infrastructure is maintained.

Initial estimations indicate that new peaking generation capacity will be required by 2007, because of the anticipated increase in demand, driven by growth in the industrial, mining, commercial and domestic sectors. A co-ordinated effort between Eskom and the department is needed to introduce new generation capacity to maintain the security of electricity supply.

The department will invite private-sector involvement through IPPs, in line with Cabinet's decision to give IPPs the opportunity to build 30% of the required generation capacity in future. Government also plans to diversify primary energy sources, thus reducing the dependence on coal for electricity generation.

The Integrated National Electrification (INEP) programme provides a socio-economic support net that ensures that previously unconnected households have access to electricity. The programme creates new infrastructure while ensuring that existing infrastructure is rehabilitated and maintained. In rolling out the programme, the department's policy is to ensure that communities become not only the recipients of government basic services, but also participants in the economy through the BEE framework.

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 INEP, to a large number of residential consumers. It sells in bulk to municipalities, which distribute to consumers within their boundaries.

The department is procuring about 1 000 MW of new generation capacity from the private sector. This is in line with government's objectives to introduce private-sector participation and to promote BEE in the energy sector. This will be achieved through a competitive tender process for IPPs to provide the required capacity by the first quarter of 2009.

One open-cycle gas turbine plant (of approximately 300 MW) is planned for the Eastern Cape and another plant (of approximately 750 MW)

will be built in KwaZulu-Natal. As part of its R84-billion expansion programme, Eskom is playing an active role as the purchaser of this energy and provider of transmission infrastructure. The process of identifying a successful bidder is expected to be finalised in 2007/08.

In 2004, Eskom announced major plans to expand its generation and transmission capacity for future electricity supply. The first step is the reintroduction of three of its previously mothballed power stations.

These are Camden in Ermelo, Grootvlei in Balfour, and Komati, between Middelburg and Bethal. Work has commenced on this project and the first unit from Camden came into commercial operation in July 2005. When fully operational by 2011, these stations should provide an additional 3 600 MW of capacity.

Eskom is implementing a number of key transmission projects over the next five years that include:

- strengthening the corridor to the Western Cape where outages illustrated the need to supplement power from Koeberg with inland electricity
- improving the transmission network to the Eastern Cape
- integrating the planned peaking power gas turbines in Atlantis and Mossel Bay into the grid
- installing new lines to new mining developments, such as platinum mines in Limpopo and iron ore projects in the Northern Cape
- strengthening the KwaZulu-Natal transmission network.

Restructuring of the electricity-supply industry

In December 1998, government released the *Energy White Paper*, which sets out its policy objectives for the entire energy sector. These objectives are to increase access to affordable energy services, improve energy governance, stimulate economic development, manage energy-related environmental impacts and secure energy supplies through diversity.

Restructuring aims to improve the quality of life of all South Africans and to increase economic growth and redeploy assets.

To ensure non-discriminatory and open access to 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. It 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, a multimarket 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.

Electricity-distribution industry (EDI)

The EDI is valued at R50 billion. In September 2005, Cabinet approved the creation of six metro regional electricity distributors (REDs) and the establishment of the national RED or any other separate RED, subject to a feasibility study to identify appropriate funding, and organisational and governance arrangements.

The EDI Holdings Company (Pty) Limited was created solely to execute government's strategic objectives of restructuring the EDI as per the requirement of the *Energy White Paper, 1998*, and the EDI restructuring blueprint of 2001, and as amplified by subsequent Cabinet decisions.

EDI Holdings established the first RED in Cape Town on 1 July 2005. However, the initial area of supply of the RED is smaller than the originally envisaged. Furthermore, due to implementation challenges, the RED only entered into operating agreements with the City of Cape Town and Eskom,

as no business transfers were effected. This will take place over the next 18 months. A service-delivery agreement was signed between the RED and the City of Cape Town.

National Energy Regulator of South Africa (Nersa)

Nersa, which was launched in November 2005, is the regulatory authority established in terms of the National Energy Regulator Act, 2004 (Act 40 of 2004), with the mandate to undertake the functions of the Gas Regulator as set out in the Gas Act, 2001 (Act 48 of 2001), the Petroleum Pipelines Regulatory Authority as set out in the Petroleum Pipelines Act, 2003 (Act 60 of 2003), and the National Electricity Regulator (NER) as set out in the Electricity Act, 1987 (Act 41 of 1987), as amended.

While the electricity industry has been regulated for the past 10 years by the NER, the piped-gas and petroleum-pipeline industries in South Africa will be regulated for the first time. Nersa is funded by the three industries through levies. The funds consist of money appropriated by Parliament, levies imposed by or under separate legislation, charges for dispute resolution, licence fees, and funds collected under section 5B of the Electricity Act, 1987.

National and regional co-operation

Nersa, represented by its CEO, was again elected as chair of the African Forum for Utility Regulators (Afur) at the 3rd Afur Annual General Assembly, which was held in March 2006 in Windhoek, Namibia.

The organisation was elected the first chair of Afur at its establishment in November 2002. Nersa is also a founding member of the Regional Electricity Regulators' Association and the South African Utility Regulators' Association, which were launched in September and October 2002 respectively.

Integrated National Electrification Programme

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

In 2005/06, R1,39 billion was spent on electrification, with R84 million allocated to non-grid electrification.

The Pebble-Bed Modular Reactor was transferred to the Department of Public Enterprises in March 2006.

Given the increasing demand for energy and the need to combat global warming, nuclear energy is re-emerging as an attractive alternative. There are 30 nuclear plants being built in 12 countries and over 50 are being planned.

The department will support the construction of a demonstration power plant and pilot fuel plant, and facilitate the timely processing of the environmental impact assessment.

Eskom continues to exceed its electrification targets. For the year to 31 March 2006, Eskom had electrified 135 868 additional homes, thus exceeding its target of 85 000. By mid-2006, it had electrified 3 346 425 homes since the inception of the INEP.

The National Electricity Basic Services Support Tariff Policy was gazetted in July 2003. The policy aims to bring relief, through government intervention, to low-income households and to ensure optimal socio-economic benefits from the INEP. Qualifying customers are eligible for 50 kilowatt-hours (kWh) of free electricity per month. Eskom is a service-provider for free basic electricity in its areas of supply.

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 kWh per household per month in terms of the policy, users pay the normal tariff for any consumption exceeding 50 kWh per month.

The programme is funded by the Department of Provincial and Local Government through the equitable share allocation.

Each household connected to the Solar Home System receives up to R48 worth of electricity a month.

Rural solar-energy users are liable for any amount above the monthly subsidy.

To make paraffin more affordable, the Department of Minerals and Energy removed the value-added tax levy on it.

Southern African Power Pool (SAPP)

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 planning and operating 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 operations costs and equitably share benefits, including reductions in generating capacity and fuel costs, and improved use of hydroelectric energy.

Member countries are Angola, Botswana, Lesotho, Malawi, Mozambique, Namibia, Swaziland, Tanzania, Zambia, Zimbabwe and the DRC.

The SAPP faces the following challenges:

- lack of infrastructure to deliver electricity
- lack of maintenance of infrastructure
- lack of funds to finance new investments
- insufficient electricity generation
- high losses.

To lay down the rules governing electricity exchange between utilities, the SAPP Agreement between operating members was drafted. By mid-2005, it had been signed by the following nine national utilities: BPC (Botswana), EDM (Mozambique), Eskom (South Africa), Snel (Zaire), Zesa (Zimbabwe), Nampower (Namibia), ZESCO (Zambia), SEB (Swaziland) and LEC (Lesotho).

Biomass

Fuel wood, obtained mainly from natural woodlands, is the primary source of energy used by households in most rural areas for cooking and heating. In some areas, this resource is 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*)

In 2005/06, Eskom was looking at harnessing biomass as a grid-supply option, while also planning to pilot new technology aimed at providing rural power in a remote area in the Eastern Cape. This technology, called a gasifier system, will use

waste from a rural sawmill to provide electricity to power the creation of business ventures in the area. The system was expected to be launched towards the end of 2006.

Renewable energy

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

The department strengthened international relationships in this area through the support offered to partnerships established during the WSSD in 2002. Such 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.

Cabinet approved the *White Paper on Renewable Energy* in November 2003, which stipulates the following target:

- 10 000 GWh renewable energy contribution to final energy consumption by 2013, to be produced mainly from biomass, wind, solar and small-scale hydro. The renewable energy is to be used for power generation and non-electric technologies such as solar water-heating and biofuels.

This is equivalent to replacing two 660 MW units of Eskom's combined coal-fired power stations, or replacing 1 100 ML of diesel (14%) with biodiesel.

This is in addition to the estimated existing 8% to 9% renewable energy contribution mainly from fuel wood and waste.

A macroeconomic analysis of the targets in the white paper concluded that:

- The target is economically viable with government financial support and 'green' funding (e.g. Clean Development Mechanism (CDM), 'green' premium etc).
- Achieving the target could add about 1 667 MW new renewable energy capacity with a net impact on GDP of as high as R1 071 million per year, in comparison with coal-fired power stations, and additional government revenue of R299 million. Just over 20 000 new jobs would be created and water savings of 16,5 million kilolitres would be achieved, translating into a R26,6-million saving. The study also highlighted the 10 000 GWh low-cost renewable energy technologies and applications to be implemented first, based on the level of commercialisation of the technology and the natural resource availability. These technologies include:
 - sugar-cane bagasse for cogeneration (59%)
 - landfill gas extraction (6%)
 - mini-hydroelectric schemes (10%)
 - commercial and domestic solar water-heaters (23%).
 - wind energy (1%)
 - biomass pulp and paper (1%)

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

Capacity-expansion options that are subject to Eskom's Clean Development Mechanism decision-making processes

Capacity-expansion option	Megawatts	Project stage in commercial use	Planned first unit commercial use	Last unit in
Camden power station	1 520	Approved	July 2005	March 2008
Grootvlei power station	1 128	Approved	September 2007	October 2009
Komati power station	961	Approved	September 2011	October 2011
Open cycle gas turbine	1 050	Approved	January 2007	April 2007
Coal-fired power station in Lehalale	1 800	Approved	September 2010	September 2012
Braamhoek pumped storage scheme ¹⁾	1 332	Approved	March 2012	December 2012
Arnot upgrade	300	Approved	November 2007	November 2010

¹⁾ Still awaiting approval as required by the Public Finance Management Act, 1999 (Act 1 of 1999)

- 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 that 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.
- Domestic and commercial solar water heating. Solar thermal-power generation is a collaborative programme with Eskom. It also involves the SolarPACES Programme of the International Energy Agency.
- Small-scale hydropower.
- Landfill gas exploitation.
- Rural water supply and sanitation.

The department's capacity-building programme for renewable energy and energy efficiency, which was funded by the Danish International Development Agency yielded significant value in capacity-building in the department, as well as various strategies and studies to support the enabling environment created by government.

The Department of Minerals and Energy and National Treasury approved the Renewable Energy Subsidy Scheme in September 2005. The scheme started off with once-off capital grants that are made available for renewable energy projects.

The website of the Renewable Energy Finance and Subsidy Office – www.dme.gov.za/dme/energy/refso.htm – was established in October 2005. It is useful as a platform for information dissemination and as a vehicle for potential applicants to access application forms.

The department is working with stakeholders such as National Treasury and Nersa on a long-term sustainable financing mechanism for grid-based renewable energy applications.

Eskom participated in a pilot project of the Department of Minerals and Energy, which

investigates green power trading. Eskom contributed to the development of draft market rules and will act as the independent market operator for the duration of the project.

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/m² 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/m² for South Africa, compared with about 150 W/m² for parts of the USA, and about 100 W/m² for Europe and the United Kingdom. This makes 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 at a monthly fee.

Once the underlying managerial and funding issues have been resolved, the process will be expanded to cover all 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 m²) and swimming pools (327 000 m²),

commerce and industry (45 000 m²) and agriculture (4 000 m²).

Three co-operatives with over 10 permanent employees each have been started in the Eastern Cape to maintain 8 000 solar home systems installed under the previous electrification programme.

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 townships, due mainly to coal burning.

Research has shown that low-cost housing could be rendered 'energy smart' through the use 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. Removing this expenditure 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 could ameliorate the situation substantially.

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

There are also 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.

A roll-out programme of solar heaters has commenced, with the focus on middle- to high-income households in Gauteng, the Western Cape and KwaZulu-Natal. The initiative is spearheaded by the CEF.

By mid-2006, a number of solar water-heating pilot projects were under way in residential and commercial buildings, with an additional pilot at an industrial site under investigation.

Solar-thermal power generation

The minimum direct normal radiation (DNR) to justify a combined solar-thermal power plant is 1 800 kWh/m² per year. According to the Renewable Energy Resource Database, the area exceeding the minimum required DNR in South Africa covers about 194 000 km². A 100-MW solar-thermal plant requires roughly 3 km² (1 800 kWh/m² per year). If 1% (1 940 km²) of the identified area is available for solar-thermal power generation, then 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).

Concentrating Solar Power (CSP) Project

To explore new-generation options, find solutions that can contribute to meeting the growing electricity demand, and in an effort to use renewable energy resources, Eskom is assessing the feasibility of constructing a CSP plant with a maximum capacity of 100 MW electricity, in the Northern Cape. This is subject to the outcome of the environmental-impact assessment and feasibility study performed in 2006.

The Upington area in the Northern Cape was identified as a feasible location for the establishment of the CSP plant. Upington further has one of the highest solar values with a direct normal insolation level of about 2 900 kWh/m² per year.

The CSP plant being considered has a molten salt-type central-receiver technology. This

technology is based on the concept of thousands of large two-axis tracking mirrors (known as heliostats), which track the sun and reflect the beam radiation to a common focal point. This focal point (the receiver) is located well above the heliostat field to prevent interference between the reflected radiation and the other heliostats.

Wind

Eskom's Klipheuwel, just north of Cape Town, is the first large wind-turbine facility in sub-Saharan Africa. The pilot phase of the Klipheuwel research and demonstration project ran from August 2002 to the end of 2005. This wind farm has a maximum capacity factor of 34%.

As far as decisions on future wind projects are concerned, the uptake of renewable energy in Eskom's mix forms part of its Integrated Strategic Electricity Planning process. Experiences gained at the demonstration facility will feed into this. However, future installation decisions will be made, based on the commercial feasibility of the proposed project.

In August 2006, the City of Cape Town signed a 20-year agreement to buy 'clean' electricity from Darling Wind Farm. Local and foreign investors, government and the community of Darling, a small town north-west of Cape Town, will collaborate to get South Africa's first commercial wind-farm venture operational.

The R70-million pilot commercial wind-energy project was expected to start operating in 2007.

The Darling Wind Farm will feed the national power grid by using four giant wind turbines to generate an estimated 13,2 GW/h of 'clean' electricity per year. It will be 'wheeled' through the grid and on to suppliers who have chosen to pay a 25c per KW/h surcharge for a 'green' power supply.

With growing concern over global warming, Cape Town expects to sell the electricity on to an initially small, but willing, market that will include businesses whose 'green credentials' will help them market their products in South Africa and abroad.

The project is the result of a partnership between the national Government, the Danish Government, the CEF and the Darling Independent Power Producing Company.

The agreement enabled Darling Wind Power to secure the necessary investment to finance the

purchase of the initial four wind turbines comprising 17-storey-high towers with massive blades powering 42-ton engine rooms at the top of the towers. Another six wind turbines will be added later, followed by another 10 in the longer term.

Hydro

An assessment conducted by the Department of Minerals and Energy, the *Baseline Study on Hydropower in South Africa*, indicated that specific areas in the country show significant potential for the development of all categories of hydropower in the short and medium term.

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 plants are that they can either be stand-alone or can exist 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.

Eskom has started the construction of the Braamhoek pumped storage scheme (1 332 MW) near Van Reenen, KwaZulu-Natal. It is expected that the first unit will be operational in 2012. Preliminary work for the design and construction of a second pumped storage scheme in the town of Steelpoort in Mpumalanga has commenced. As peak demand for electricity continues to grow, Eskom will continue to explore the development of new hydroelectric and pumped storage schemes as part of its renewable energy mix.

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).

The main project outside South Africa's borders is Westcor. It entails a five-way intergovernmental MoU signed between the utilities of the DRC, Angola, Namibia, Botswana and South Africa. Westcor will tap into some of the potential in the DRC. The first project is Inga III, a 3 500-MW hydro plant on the Congo River.

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 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 Project can 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 are likely to limit the exploitation of hydropower on a large scale.

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

Ocean energy

Ocean energy could potentially be derived from the various characteristics of the sea. For example, the rise and fall of the waves can be converted into hydraulic pressure by mechanical compression devices. Such pressure can drive a turbine generator to produce electricity, while the tidal variation, sea current and different thermal layers in the ocean can also be used.

The main reason why this energy resource is not currently being harnessed is that no reliable technology exists that can generate electricity from this resource. Various companies are testing systems internationally to develop technically viable solutions. Once technical reliability has been proven, cost-effectiveness in relation to other solutions will have to be proven.

Eskom completed an ocean-energy resource assessment in 2002. The study concluded that South Africa has a sufficient ocean resource to explore this option further. A techno-economic study and technology evaluation are being performed. This study aims to assess those ocean-energy conversion technologies being tested internationally, to determine which option should be researched further for possible application in South Africa.

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 countrywide. This causes indoor air-pollution problems, which have a serious health impact.

It has been found that in some cases, especially regarding particulate matter, exposure can exceed World Health Organisation (WHO) standards (180 mg.m⁻³) by factors of six to seven during winter, and two to three in summer. A national programme has been established to introduce low-smoke energy 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 of Minerals and Energy 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 roleplayers to address the problem.

In 2006, the department completed the new national standard for non-pressure paraffin stoves and heaters.

Designated National Authority (DNA)

Implementation of the Kyoto Protocol came into effect on 16 February 2005.

The department established the DNA to review CDM projects. The purpose of this initiative is to ensure that the CDM investment taking place in South Africa is in line with sustainable-development objectives addressing economic, environment and social development with emphasis on job creation, poverty alleviation and technology and skills transfer.

CDM projects approved by the DNA have the potential to contribute to the renewable energy and energy efficiency target, while also assisting various industries to reduce energy consumption and contribute to the improvement of the local and global environment by reducing GHG emissions and air pollution.

The DNA had approved 30 projects by mid-2006.

Geology

South Africa has a long and complex geological history dating back more than 3 700 billion years. Significant fragments of this geology have been preserved and along with them, mineral deposits.

The preservation of so much Archaean geology, dating back more than 2 500 million years, has resulted in the Archaean Witwatersrand Basin being preserved, as well as several greenstone belts. Ten of the more significant geological formations in South Africa are discussed below.

Barberton mountain land

This beautiful and rugged tract of country with some of the oldest rocks on Earth is situated south of Nelspruit in Mpumalanga. The renowned Barberton

Greenstone Belt, the largest of its kind in South Africa, contains remnants of original crust, dated around 3,5 billion years old. The greenstone formations represent the remains of some of 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 that are more than 3 000 million years old.


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

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 Witwatersrand conglomerate reefs that were discovered in 1886, not far from the Johannesburg city centre.

The Witwatersrand is the greatest goldfield known to mankind. More than 50 055 t of gold have been produced from seven major goldfields distributed in a crescent-like shape along 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 contains the important gold-bearing quartz-pebble conglomerates. These 'gold reefs' were formed from

 At the four-day African Ministerial Conference on Hydropower and Sustainable Development in Johannesburg in March 2006, African leaders committed themselves to developing a continent-wide energy vision for 2025. It will be monitored by ministers of finance, energy, water and the environment, under the auspices of the African Union.

Delegates agreed that exploiting the potential of hydropower as renewable energy could help meet the continent's power needs, and concurred that the development of hydropower should be underpinned by sound environmental and impact assessments, and mitigation and management plans, in accordance with national regulatory frameworks and international standards of good practice.

In Africa, less than 70% of hydropower potential has been developed.

gravels transported into the basin and reworked 2,75 billion years ago. The gold and uranium originated from a rich source in the hinterland.

Bushveld Complex and Escarpment

The Bushveld Complex extends over an area of 65 000 km² and reaches up to 8 km in thickness. It is by far the largest known layered igneous intrusion in the world and contains most of the world's resources of chromium, PGMs and vanadium. This mega-complex was emplaced in a molten state about 2 060 billion 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 this area are the imposing Dwars River chromitite layers, 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 2,5 billion-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 by the partial erosion plateau of basaltic lava, which is more than 1 500 m thick, and covers the Clarens sandstones. Prior to its erosion, the continental basalt field covered significantly more of the continent.

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 scenic Golden Gate Highlands National Park in the Free State features spectacular sandstone bluffs and cliffs. The sandstone reflects a sandy desert environment that existed around 200 million

years ago. Dinosaur fossils are still found in the area.

Karoo

Rocks of the Karoo Supergroup cover most of South Africa and reach a thickness of several thousand metres. The sedimentary portion of this rock sequence reveals an almost continuous record of deposition and life, from the end of the Carboniferous into the mid-Jurassic periods, between 300 million 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 their early dinosaur evolution.

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

Initially, the prehistoric Karoo was a place of vast glaciation. It then became a shallow inland sea, before this was replaced by huge rivers, with lush flood plains and swampy deltas, which dried out to a sandy desert. Finally, vast outpourings of continental basaltic lava accompanied by the break-up of Gondwana occurred.

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' was encountered and this 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 Dome, the oldest and largest visible impact structure known on Earth.

Declared a world heritage site in 2005, it lies 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, was caused by the impact of a 10-km wide asteroid some two billion years ago. Only a ring of hills remains of the dome created by the rebound of rock below the asteroid's impact site. The original crater – now eroded – is estimated to have been between 250 km and 300 km in diameter.

The Vredefort structure comprises a core zone of granitic rocks, surrounded by a ring-like collar zone of younger bedded formations. Only the north-western portion of the structure remains visible. The south-eastern half was flooded by sediments of the Karoo Supergroup, which cover the Free State.

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 some 1,5 billion years ago.

The remains of ancient lava flows and vulcanic 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

Located mainly in Gauteng, this World Heritage Site extends from 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 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 palaeoanthropological research.

Table Mountain and the Cape Peninsula

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

The earliest of these are the deformed slates of the Malmesbury Group which formed between 560 million 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, that is well-exposed along Chapman's Peak. 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.

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