



SA YEARBOOK 2007/08 | 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 Hydrocarbons and Energy Planning Branch is responsible for coal, gas, liquid fuels, energy efficiency, renewable energy, designated national authority and energy planning, data and statistics, the roll-out of integrated energy centres (IECs) 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 contribute to sustainable development.

### Policy

Mining and minerals policy is based on the principles of the Freedom Charter, according to which the mineral wealth beneath the soil will be transferred to the ownership of the people as a whole.

The Mineral and Petroleum Resources Development Act (MPRDA), 2002 (Act 28 of 2002), has opened doors for the substantial and meaningful participation of black people in the exploration and exploitation of mineral resources. The MPRDA, 2002 enshrines equal access to mineral resources, irrespective of race, gender and creed.

By April 2007, the Department of Minerals and Energy had received 11 447 applications for various types of rights since the promulgation of the MPRDA, 2002 in April 2004. This number of applications is unprecedented in the history of mining in South Africa.

Aided by the Department of Minerals and Energy, skills development is taking place in the jewellery sector to enable people to take leadership roles and the provinces to play supporting roles. This follows the introduction of the Diamonds Amendment Act, 2005 (Act 29 of 2005), the Diamonds Second Amendment Act, 2005 (Act 30 of 2005), and the Precious Metals Act 2005 (Act 37 of 2005). These amendments will see a more representative South

African Diamonds and Precious Metals Regulator replacing the South African Diamond Board. The Diamond Exchange and Export Centre will monitor the export of diamonds, while the State Diamond Trader will make diamonds available exclusively to beneficiaries of diamonds. It will open in Johannesburg initially and move to Kimberley in the Northern Cape later.

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

### Implementation of the Mineral and Petroleum Resources Development Act, 2002

The Department of Minerals and Energy's efforts to pursue and consolidate gender empowerment in the mining industry have culminated in the revitalisation of the South African Women in Mining Association (SAWIMA) and the official launch of their national offices in Johannesburg. Through the SAWIMA, the department will continue to lend assistance to women in mining to ensure that this sector does not continue to be the domain of men only.

Youth in Energy and Mining was established in 2006 to facilitate youth programmes and reach out to as many youth in the country as possible. To further fulfil the objectives of the Joint Initiative on Priority Skills Acquisition (Jipsa), the Council for Geoscience, the Central Energy Fund (CEF) Group of Companies and the University of Fort Hare are collaborating on a skills-development programme in the fields of geology, chemistry and economics.

Furthermore, the department uses the MPRDA, 2002, through its requirements for a social and labour plan, to intensify the struggle against poverty.

Housing projects, schools and clinics are initiatives undertaken by mining companies in an effort to fulfil the criteria as set out in the Act.

### 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.

Considering the extent of environmental damage caused by mining in South Africa, the department has entered into a five-year agreement with the Council for Scientific and Industrial Research (CSIR), the Council for Geoscience and Mintek to find solutions for long-term rehabilitation and environmental management.

The need for a national strategy dealing with derelict and ownerless mines is evident in the more than 8 000 entries on the database for such mines in South Africa. A ranking system has been developed to prioritise the rehabilitation of these mines and a dedicated geographic information system and an environmental auditing system have been finalised to strengthen environmental decision-making and the enforcement of environmental regulations. These systems will be integrated with the existing national mining promotion system.

### **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 mining outcomes, 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:

- eradicating poverty
- 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

mining and mineral-related initiatives of the New Partnership for Africa's Development (Nepad). The Global Mining Dialogue was also established to promote WSSD mining outcomes in the international arena.

The fourth AMP plenary, held in Pretoria in February 2007, further advanced collective efforts by African mining ministers to find the best ways to alleviate poverty in Africa via mining. Specific small-scale projects were identified so that their feasibility could be evaluated. During the AMP's plenary, the Association of African Geological Surveys (AAGS) was launched. Its members expected to publish the Council for Geoscience geological map for the Southern African Development Community (SADC) in 2007/08, which AAGS members created.

South Africa's Cabinet agrees that African countries have to develop and adopt a common position on environmental matters that highlights the links between eradicating poverty, sustainable development and maintaining the long-term integrity of natural resources. The Department of Environmental Affairs and Tourism is taking the lead in developing South Africa's position, including addressing issues covered by the Kyoto Protocol and targets set at the WSSD.

The dialogue was instrumental in establishing the Intergovernmental Forum on Mining, Minerals, Metals and Sustainable Development. The 15th session of the United Nations (UN) Commission on Sustainable Development (CSD), met in New York from 30 April to 11 May 2007. The CSD's mandate is to follow-up, monitor and report on the JPI.

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

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

The Mining Charter, which is founded on an accord reached between government and the private mining sector, espouses the cause of BEE.

In June 2007, the Department of Minerals and Energy announced that the South African Supplier Development Agency (Sasda) would be incorporated into the CEF Group of Companies as part of broader initiatives to accelerate the empowerment of BEE suppliers in the oil industry.

Sasda was established in March 2005 by the department in conjunction with the seven major oil companies which constitute the South African Petroleum Industry Association (Sapia). Sasda's brief is to facilitate increased access by BEE suppliers to procurement opportunities in the petroleum industry, in compliance with the Liquid Fuels Charter of 2000. One of its key focus areas is the development of black suppliers to meet the industry's required standards.

### Mining industry

The commodities boom of 2005 continued into 2006. Preliminary figures for 2006 indicated that mineral sales grew by 36,7% to R195,2 billion, and those of processed minerals grew at a moderate 14,5%. Unlike in other mining countries, this strong growth in mineral sales was initially not matched by any meaningful fixed capital investment.

A marked improvement has been noted in this area. New BEE-compliant mines have been opened, especially in Limpopo and North West; and International Ferrometal South Africa was officially opened near Brits in the North West.

Reports about the lack of direct investment in the sector resulted in the department conducting international roadshows to better understand the

obstacles to investments. Together with the Chamber of Mines and the National Union of Mineworkers, a desktop study was conducted that indicated some of the causes of this lack of investment.

An all-inclusive indaba in June 2007 discussed all the aspects of the industry to develop concrete strategies. The results from the indaba were fed into the work of the Accelerated and Shared Growth Initiative for South Africa (AsgiSA).

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

In April 2007, the Minister of Public Enterprises, Mr Alec Erwin, signed a land-settlement agreement with the Richtersveld community for the return of the 84 000 hectares of diamond-bearing land on the Namaqualand coast. The deed settlement became effective in October 2007. It will make the Richtersveld community owners of Alexkor, the State diamond-mining company, and will allow the community to use Alexkor as a commercial vehicle for their own development.

The landmark settlement agreement includes:

- restoring the land claimed
- restoring the mineral rights by way of transfer of Alexkor's land-mining rights
- a lump sum developmental grant of R50 million
- R190-million compensation over three years as reparation payment
- transferring agricultural and mariculture assets
- establishing a formal township at Alexander Bay
- environmental rehabilitation.

### Mineworkers

According to the Chamber of Mines, the South African mining sector in 2005:

- Directly employed about 442 911 workers, compared with 457 371 in 2004. It was estimated that another 147 673 workers were employed in



In February 2007, the Department of Minerals and Energy and mining group De Beers announced an agreement aimed at creating an even more empowered and sustainable diamond-mining and exploration industry in the country.

In terms of this agreement, the West Coast operations of Alexkor and De Beers Consolidated Mines' Namaqualand Mines will be amalgamated into a new, stand-alone diamond-mining company. This independent and empowered company will, among other things, capitalise on synergies and realise the full economic potential of the West Coast diamond-mining industry. As a first step, De Beers issued a 20% stake in its Namaqualand Mines to the department.



associated industries that either supplied products to, or used products from the mining industry (the multiplier linkages of the industry). Around five million people are directly dependent for their daily subsistence on mine employees.

- Accounted for 6,2% of those employed in the non-agricultural formal sector of the economy and 8% of the total private sector of non-agricultural employment.
- Paid R36,4 billion in wages and benefits to employees, which accounted for about 5,4% of the total compensation paid to all employed people in the country. This contributed substantially to domestic demand in the South African economy.

### **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 mineworkers or people affected by mining activities.

The activities of the MHSI focus 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.

Some 199 miners died in mine accidents in 2006 and about 4 000 people were injured. The mining sector failed to achieve the targets agreed to in 2003, of reducing the fatality rate by at least 20% a year.

Further analysis shows that fatalities in the platinum sector dropped by 21%, but there is still room for improvement.

The Mini-Indaba on Seismicity and Rockbursts was held in October 2007.

The department continues to work with security forces to develop a strategy of combating illegal mining, which is one of the biggest threats to mineworkers' health and safety.

The biennial Mine Health and Safety Council Summit was held on 5 October 2007 in Johannesburg, where the status of occupational health and safety in mines was discussed, including the progress on achieving the milestones agreed to in 2003.

South Africa is committed to combating the HIV and AIDS pandemic in the mining industry. The Mining Industry Tripartite HIV and AIDS Committee observed the 2007 World AIDS Day.

### **Mine Qualifications Authority (MQA)**

The MQA was established as a sector education and training authority under the leadership of the Department of Labour. 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 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. Firstly, 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 through grants for training in small-scale mining, mineral beneficiation, jewellery manufacturing and diamond processing.

The human resources development guidelines provide for enhanced opportunities to be made available to historically disadvantaged individuals (HDIs) within the mining and minerals sector. They specify that by 2010, 40% of managers controlling the full spectrum of activities should be from historically disadvantaged backgrounds and women must occupy 10% of all positions.

Consequently, the MQA Executive Preparation Programme (EPP) was created to aid HDIs. Its focus is on developing strategic and in-depth understanding of the mining and minerals sector in some 26 learners per six-month term.

The Graduate Development Programme was also introduced for unemployed graduates from universities of technology who had qualifications and skills that were scarce and critical according to the Mineral Sector Skills Plan, but who needed to gain work experience.

By August 2007, 103 candidates had completed the executive programme and 26 had graduated, and 200 graduate development programme candidates had received letters recognising their participation.

### 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.

Subsidiary companies provide training, examination administration, visits to operational gold and diamond mines, the monthly newspaper *Mining News*, mine-rescue, environmental management, and centres for human development

to the South African mining industry and, in some instances, also to customers outside the mining industry.

Other areas of industry networking include:

- the Employment Bureau of Africa (Teba)
- Teba-Bank, which provides efficient and cost-effective banking services for mineworkers
- Rand Mutual Assurance, which provides compensation benefits for accidental injury or workers' death while on duty.
- 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
- Mintek, which specialises in mineral processing, extractive metallurgy and related areas.

### Junior and small-scale mining

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

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.

The department's 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 its 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 contributes significantly 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 given assistance. Experience has shown that just providing institutional support is inadequate. There is also a need to involve technical partners or business professionals to mentor each project to its completion.

The framework's target market for assistance comprises:

- illegal or unacceptable operations, which are legalised and converted into sustainable operations
- undercapitalised operations which require expansion or optimisation
- first-time entrepreneurs interested in new 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.

The department continued supporting the development of small-scale mining and, for the first time, extended this support to jewellery-fabrication projects in 2007.

Both interventions contributed immensely to the Second Economy. Its annual budget of R21 million enabled the department to support four projects in Limpopo to the tune of R14, 6 million and three in KwaZulu-Natal at R7,2 million. In 2006, the department received more than 80 applications for financial assistance and expected the figure to double in 2007.

### 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 deposits) – the country is among the world's top producers.
- Titanium – heavy mineral-sand occurrences containing titanium minerals are found along the coastline.
- Manganese – enormous reserves of manganese are found in the sedimentary rocks of the Transvaal Supergroup.
- Platinum-group metals (PGMs), chrome and vanadium – these minerals occur in the Bushveld Complex in Mpumalanga, Limpopo and North West. More than half of the world's chrome and platinum reserves are in this deposit.
- Bituminous coal and anthracite seams occur in the Karoo Basin in Mpumalanga, KwaZulu-Natal, the 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 mineral reserves, 2006

Commodity	Unit	Reserves	%	World ranking
Alumino-silicates	Kt	51	n/a	n/a
Antimony	t	200	6,4	4
Chrome ore	Kt	5 500	72,4	1
Coal	Mt	31 022	3,5	8
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	7
Manganese ore	Kt	4 000	80	1
Phosphate rock	Kt	2 500	5	4
Platinum-group metals	Kg	70 000	87,7	1
Silver	t	n/a	n/a	n/a
Titanium minerals	Mt	220	18,3	2
Uranium	t	341	7,2	5
Vanadium	Kt	12 000	31	1
Vermiculite	Kt	80	40	2
Zinc metal	Kt	15	3,3	8
Zirconium	Kt	14	19,4	2

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

Source: Minerals Bureau

South Africa's reserves of the following commodities are globally the highest, namely:

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

Due to the small domestic market for most commodities, South Africa's mineral industry is export-oriented. 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, and 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 regarding the supply of minerals. However, some minerals and mineral products need to be imported.

South Africa's total sales of primary minerals increased to R142,8 billion in 2005. The value of exports of primary minerals in 2005 increased to R101,9 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

South African gold output fell 7,6% to 2,02 million ounces (62 807 kg) in the first three months of 2007 compared with the same period in 2006.



The National Hydrogen and Fuel Cells Technology Research Development and Innovation Strategy has been approved. Hydrogen and fuel cells are seen as energy solutions for the 21st century, enabling clean and efficient production of energy from a range of primary energy sources.

The transition to hydrogen is expected to reduce dependence on oil and gas and reduce carbon dioxide emissions. The strategy will enable government to support emerging research and development in this strategic field.

South Africa's gold production tumbled by 3,1% in the fourth quarter of 2006 to 68 118 kg, compared with the previous quarter.

The lowest levels of gold production since 1922 occurred in 2006, despite gold prices reaching multiyear record highs during the year.

On a year-on-year basis, the rate of decline rose to 9,3% in the fourth quarter compared with the 2,9% decline recorded in the third quarter of 2006.

The Chamber of Mine's members reported a quarter-on-quarter gold-mine production decline of 2,6% to 58 342 kg in the fourth quarter of 2006.

On a year-on-year basis, gold production declined by 10% in the last quarter of 2006, as the 4,9% increase in tons of ore milled was insufficient to compensate for the 14,2% decline in the average grade mined.

On 6 November 2007, the gold price rose to its highest level in nearly three decades after crude oil jumped more than a dollar on supply concerns.

The cost of spot gold hit an intraday high of US\$814,10 an ounce, its best level since January 1980, before slipping to US\$813,50/814,25 an ounce, higher than US\$808,80/809,60 late in New York.

### Silver

Silver hit an intraday high of US\$14,84 an ounce early in November 2007, its highest level since mid-May 2006, before easing to US\$14,83/14,88.

### Coal

In 2006, South African mines produced 246 million tons (Mt) of coal. Of this figure, 177 Mt was used locally, at a value of R16,2 billion, with export sales totalling 68,8 Mt at a value of R21,2 billion. South Africa has approximately 31 billion tons of recoverable coal reserves, making it the sixth-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.

## Non-ferrous minerals

Refined copper, nickel, cobalt, titanium and zirconium concentrates dominate this sector, followed by 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 state 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 higher dollar earnings being 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.

## 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 2012
- 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.

South Africa's mineral production, 2006

Commodity	Unit	Reserves	%	World ranking
Aluminium	Kt	846	2,7	9
Alumino-silicates	Kt	228	36,4	1
Antimony	t	5 979	3,2	7
Chrome ore	Kt	7 494	38,7	1
Coal	Mt	245	4,9	5
Copper	Kt	97	0,7	16
Fluorspar	Mt	n/a	n/a	n/a
Gold	t	295	11,7	1
Iron ore	Mt	40	3	7
Lead	Mt	42,2	1,2	13
Manganese ore	Kt	4 612	13,3	2
Nickel	Kt	42,4	3,1	9
Phosphate rock	Kt	2 577	1,7	10
Platinum-group metals	Kg	303	56,7	1
Silver	t	88	0,4	17
Titanium minerals	Mt	952	19,8	2
Uranium	t	795	1,6	11
Vanadium	Kt	23	48	1
Vermiculite	Kt	210	39,6	1
Zinc metal	Kt	32,1	0,3	22
Zirconium minerals	Kt	n/a	n/a	n/a

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

Source: Minerals Bureau

Estimates suggest that R107 billion will be needed between 2005 and 2009 to meet the country's growing energy needs. Eskom will invest R150 billion over the next five years. Some R23 billion is reserved for independent power producer (IPP) entrants.

In August 2007, Cabinet approved the Energy Security Strategy, a policy document that will change South Africa's approach to energy security.

The fuel shortages of 2005 and projected challenges coming out of studies conducted since then, as well as the blackouts that have hit the electricity supply industry raised the need for the strategy.

The strategy is presented in phases with phase one focusing on liquid-fuels issues, the energy security framework and the proposed energy planning approach. Phase two will address issues pertaining to electricity.

The approved strategy seeks to:

- secure adequate supplies of affordable energy for continued economic growth and development in the short term
- enable policy and decision-makers to make informed decisions on these complex interdependent energy outcomes in the medium term
- ensure that strategic planning and subsequent growth and development are sustainable in the long term.

Key elements of the policy include:

- Implementing the Integrated Energy Modelling and Planning Approach, which is aimed at

ensuring co-ordination and enhanced planning integration in dealing with future energy policy in support of achieving energy security.

- Publishing the Energy Security Master Plan. Phase one focuses on liquid fuels, and the Energy Security Master Plan and phase two, focuses on the short- to medium-term interventions in the electricity sector, as well as integration with the liquid-fuels sector.
- Improving Spoornet's operational efficiencies regarding its service to the liquid-fuels sector, by focusing on routes that allow for block trains/block loads, as well as the allocation of additional capacity to the Durban-Gauteng corridor.
- Improving operational efficiencies at ports, especially during periods of increased demand for imported crude oil or refined products in South Africa. This includes ensuring that back-of-port facilities are not used as part of refining operations.
- Promoting local refining as far as possible, with a particular preference for production from local resources, including those from South Africa's neighbouring states.
- Developing the Transnet Pipelines' new Multi-Products Pipeline, which is necessary to alleviate the identified capacity constraints in the petroleum supply chain by 2010.
- Promoting energy efficiency and other demand-side initiatives in all energy-demand sectors of the economy. This should be complemented by measures aimed at effectively managing interactions with the natural environment.



Eskom has a licence to build the country's first coal-fired power station in over 20 years.

The station, to be called Medupi, is located in Lephalale, Limpopo, and consists of six units with a 4 500-megawatt installed capacity.

The units will be commissioned between 2011 and 2015 at nine-month intervals.

The project will include supercritical boilers, which are able to operate at higher temperatures and pressures than older-generation boilers and, more importantly, with greater efficiency.

This is the first step towards a much-needed base load station for South Africa.

### Energy in the economy

Energy comprises about 15% of South Africa's gross domestic product (GDP), and creates jobs for about 250 000 people. Eskom's total electricity sales had grown to 218 120 gigawatt/hour (GWh) by March 2007.

Contributing to this performance was high growth in sales volumes of 4,9% compared with the budget of 2,3%. The peak demand on the integrated system totalled 34 807 MW by June 2006. In 2001, total liquid-fuel sales 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. Diversification of the primary energy mix, which comprises 88% coal, is especially challenging.

South Africa has an abundance of low-cost coal, which means that reliable and inexpensive supplies are at hand. On the face of it, this facilitates Eskom's mandate of providing South Africa with affordable and reliable electricity.

Yet Eskom also has a duty to manage environmental impacts and has a responsibility to combat climate change.

### Energy efficiency

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

In June 2007, the Department of Minerals and Energy launched the Intensive Multimedia Energy-Efficiency Campaign in partnership with the Department of Public Enterprises, Eskom and other state organs. The campaign targets ordinary households and industrial consumers with a view to influencing prudent consumer behavioural patterns without negatively affecting the economy.

This intervention should yield enormous benefits in the form of lower energy demand, energy security being promoted, and a contribution to environmental conservation and savings for individual households.

All state-owned enterprises (SOEs) 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, thus committing themselves to targets in the department's strategy.

By mid-2007, the Department of Minerals and Energy was making progress in implementing the national Energy-Efficiency Accord.

The CEF is expected to ensure that South Africa's energy is fully developed and used efficiently for the benefit of all South Africans. The CEF established two new energy bodies to deal with the country's energy challenges. These are the National

Energy Efficiency Agency (NEEA) and the South African National Energy Research Institute (Saneri).

The NEEA is a division of the CEF and will oversee the implementation of Eskom's Demand-Side Management (DSM) and other energy-efficiency projects.

The NEEA's initial focus will be on prioritising and recommending energy efficiency and DSM projects.

It will develop strategies to address the growing demand for all kinds of energy in South Africa. It will also create energy efficiency and DSM awareness campaigns to assist the public when purchasing energy-consuming equipment and appliances.

The NEEA will oversee the integration and co-ordination of training in existing energy-efficiency projects, and assist with skills transfer, capacity-building and the creation of additional jobs in the field of energy conservation.

In line with the national Energy-Efficiency Strategy, the NEEA will be subject to review every three years. Initially, it will operate under the CEF corporate umbrella, but is expected to develop its own unique identity as time progresses.

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 vehicle's fuel consumption and its carbon-dioxide emissions.

Saneri is designed to generate new ideas to develop practical guidelines for taking advantage of the natural resources of clean and renewable energy.



In June 2007, the Minister of Minerals and Energy, Ms Buyelwa Sonjica, launched two youth programmes in partnership with Anglo American and Xstrata Mining. She also signed a memorandum of understanding with the Umsobomvu Youth Fund to assist youth who want to pursue entrepreneurial projects in minerals and energy.

These programmes are industry-supported government initiatives to intensify the participation of youth in the minerals and energy sector.

The department has initiated projects and programmes focusing on youth-development programmes in partnership with Youth in Energy and Mining and Industry. The programme targets youth who have an interest in the minerals and energy sectors, skills development, procurement, beneficiation, enterprise development and small-scale mining. Xstrata Mining has set aside R1 million for skills-development training programmes.

Saneri is a subsidiary of the CEF, and will be responsible for facilitating skills development and undertaking research and technology development that will ensure that South Africa's energy resources are used and optimised. The research institute will be based at the CEF's head offices in Rosebank, Johannesburg.

Eskom launched a DSM, which is intended to reduce demand by approximately 3 000 MW by 2012 and a further 5 000 MW by 2025. The programme's objective is to alleviate imminent supply constraints and obviate the need for more costly supply options. Eskom will pursue energy-saving measures nationally, following the success of a campaign that saved about 500 MW a day in 2006 in the Western Cape during power shortages in winter.

### 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 decisions.

The Department of Minerals and Energy, in collaboration with Statistics South Africa, is responsible for providing energy data and statistics.

It has initiated 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 providing energy balances to one year.

Energy statistics are available from 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 service-providers and energy suppliers adopt an integrated resource-planning approach for large investment decisions, 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 has commissioned the development of the National Integrated Energy Modelling System.

The system is expected to be in place in 2009, and will allow for data capturing and the development of a long-term energy plan.

### Integrated Energy Centres Programme

The department, in partnership with municipalities, oil companies and other stakeholders, is establishing IECs countrywide. The main objective is to bring affordable and sustainable energy services and information closer to poor communities.

Underlying this is a strong social-responsibility drive aimed at poverty alleviation, job creation and capacity-building.

By April 2007, there were five operational IECs, namely, Kgalagadi IEC in Kuruman, Northern Cape; Caba Mdeni IEC in Matatiele, Eastern Cape; Moshaweng IEC in Laxey, Northern Cape; Eshane IEC in Greytown, KwaZulu-Natal; and Mutale IEC, Limpopo. Other IECs are at various stages of development.

The department has approved a sustainability strategy and roll-out plan to establish more IECs until 2015, targeting the nodal areas first, followed by peri-urban and urban areas.

The department hosted an IEC investment conference in October 2006 and invited potential partners from various oil companies and other energy institutions to attend. These partnerships will roll out the plan to establish more of these centres.

IECs contribute to job creation both directly and indirectly by employing permanent staff and village vendors, and contribute to cost-savings by the community at large by bringing energy sources and services to them, thereby reducing transport costs.

By mid-2007, a strategy and roll-out plan to establish more IECs had been approved.

## **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).

Currently, South Africa produces over 10 000 t of this commodity a year. The total sales of the product generate turnover of close to R2 billion. LPG consumption has been growing at an average of 4% over the past few years. South African LPG consumers include commercial, industrial and households.

LPG can also be used by low-income households in both rural and urban areas in South Africa.

The number of households with access to electricity has almost doubled since 1995. In that year, the number of households with access to electricity was 4,47 million. This number increased to 7,73 million in 2001 and stood at 9,56 million in 2006. Electricity for lighting has increased across South Africa with 80% of households with 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.

Coal meets about 88% of South Africa's primary energy needs. Eskom announced its intention to begin diversifying its primary energy mix (using less coal) five years ago. By mid-2007, it was building open-cycle gas turbines at Atlantis and Mossel Bay, of which 1 029 MW was expected to be commissioned. In addition, Eskom plans to build a 100-MW wind facility in the near future, pending licensing approvals, and will upgrade the Gariep Hydroelectric Power Station (80 MW). Feasibility studies continue regarding other renewable-energy and gas-plant initiatives.

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 28% of South Africa's

production is exported internationally, mainly through the Richards Bay Coal Terminal, making South Africa the fifth-largest coal-exporter in the world.

South Africa's coal is obtained from collieries ranging from among the largest in the world to small-scale producers. Operating collieries decreased to 60 during 2006. Of these, a relatively small number of large-scale producers supply coal primarily to electricity and synthetic fuel producers. About 46,5% of South African coal mining is done underground and about 53,5% is produced by opencast methods.

The coal-mining industry is highly concentrated, with six companies, namely Anglo Coal, BHP Billiton, Sasol Mining, Eyesizwe Coal, Kumba Coal and Xstrata Coal accounting for 90% of the saleable coal production. The eight-largest mines account for 61% of the output.

South African coal for local electricity production is among the cheapest in the world. The beneficiation of coal, particularly for export, results in more than 65 Mt of coal discards being produced annually.

The remainder of South Africa's coal production feeds the various local industries. About 109 Mt is used for electricity generation; 44 Mt for petrochemical industries such as Sasol; 9,7 Mt for general industry; and 5,7 Mt for the metallurgical industry. Coal merchants buy 8,4 Mt to sell locally or abroad.

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

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 extraction of coal also affects the environment negatively. The department and coal-mining industry are fostering the introduction of clean coal technologies in South Africa.

Eskom has successfully commissioned an underground coal-gasification pilot plant next to Majuba Power Station in Mpumalanga. The underground coal-gasification process uses a matrix of wells drilled into the coal bed.

Air is injected and the coal is ignited underground, thus producing a synthetic gas which

is harvested and used as fuel for either boilers or turbines. Gas from the pilot plant was successfully flared in January 2007, demonstrating that the process works.

The technology promises a commercially competitive combustible gas, and has synergies with conventional mining, that would enable mines to exploit coal reserves that could not normally be mined. This application is a first for Africa and the frontrunner in terms of Eskom's research into clean coal technologies.

### 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). The Department of Minerals and Energy administers these acts. The Department of Health administers the Hazardous Substances Act, 1973 (Act 15 of 1973), related to groups III and IV hazardous substances.

Approval of the Nuclear Energy Policy and Strategy is expected to result in the creation of many jobs and a boost to the economy. The document proposes the increased use of nuclear energy to supplement current energy sources.

Nuclear energy is likely to contribute 15% of South Africa's energy in the next 30 years. If the strategy is approved, an extra 10 000 MW could be added to the current 39 000 MW in 10 years. This would entail recapitalising certain nuclear agencies, financing others and setting up new ones.

The draft document sets out a phased approach to creating a nuclear industry. Infrastructure would be maintained and upgraded until 2010. Thereafter, up to 2015, new nuclear power plants will be constructed and will become operational in 2025.

The document also proposes that enriched uranium be sold internationally, allowing the country to compete in the global nuclear market.

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

- The Department of Minerals and Energy 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 undertakes and promotes research and development (R&D) 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 oversees safety regulation of nuclear installations and activities involving radioactive material at Necsa's Pelindaba site, Vaalputs Radioactive Waste Disposal Facility, the Koeberg Nuclear Power Station, certain mines and other small users.
- The Department of Health (Directorate: Radiation Control) 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 is responsible for about 6,5% of total electricity generation. It is owned by Eskom, which reports to the Minister of Public Enterprises.
- iThemba Laboratories is responsible for medical isotopes and medical applications. This public entity falls under the Department of Science and Technology.
- Nufcor is responsible for uranium-ore refinement and export. It is privately owned by AngloGold.

In February 2007, President Thabo Mbeki announced that government would be accelerating preparatory work to ensure greater reliance on nuclear energy and renewable energies.

Regarding nuclear energy, the department tabled a draft nuclear energy policy and strategy in mid-2007. The policy will guide the Expanded Nuclear Build Programme and address the issue of investment in uranium beneficiation. It will also

ensure that uranium output from mines is used to satisfy South Africa's own beneficiation needs first. The department continues to participate in the Women in Nuclear South Africa (WINSA) Programme. Government is expected to accelerate preparatory work to ensure greater reliance on nuclear energy and other renewable energies.

The department has introduced initiatives such as the South African Young Nuclear Professionals Society and WINSA to promote the industry among historically disadvantaged people.

Necsa will receive R10 million a year for the next three years to establish the National Nuclear Manufacturing Centre. It will incorporate Necsa's existing facilities at the Pelindaba complex outside Pretoria, including Fabritek (the manufacturing component of the former Atomic Energy Corporation), an existing design centre, and Necsa's current fuel manufacturing activities at the Safari-1 research reactor.

This centre intends to do its own manufacturing but also assists other South African companies to meet the required standards and be able to manufacture for nuclear.

The NNR has to strengthen its capacity to evaluate different technologies, and the State will also have to improve its system for ensuring compliance with its non-proliferation obligations.

The expanded nuclear programme is expected to result in the development of a nuclear energy industrial complex, which will lead to job creation in the nuclear sector. This envisaged energy complex will centre on uranium beneficiation and power-plant manufacturing infrastructure.

### 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.

Sapia announced strong growth in petroleum product sales in the first quarter of 2007.

Aggregate sales of major petroleum products showed a strong increase of 7,3% in the first quarter of 2007, as compared with the first quarter of 2006. The most significant increases were in diesel (13,1%), bitumen (36,3%) and LPG (15%).

Petrol sales grew by 4,4% and jet fuel sales by 4,6%.

Paraffin sales declined by 13,4%, indicating that this product is being used less for household energy.

In the first quarter, the percentage split of petrol sales between unleaded petrol (ULP) and lead-replacement petrol (LRP) was 64% for ULP and 36% for LRP.

This represents a significant increase in the penetration of ULP from the prevailing level of 43% in May 2006. This indicates that demand for LRP is declining.

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

The National Petroleum, Gas and Oil Corporation of South Africa (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.

The Department of Minerals and Energy, together with the oil industry, established the Fuel Strategic



In June 2007, the Draft Petroleum Pipelines Regulations were gazetted for public comment in accordance with Section 33 of the Petroleum Pipelines Act, 2003 (Act 60 of 2003).

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

- promote competition in the construction and operation of petroleum infrastructure
- promote the efficient and orderly development, operation and use of petroleum infrastructure
- ensure safe and efficient transport, loading and storage of petroleum
- promote equitable access to pipelines, loading and storage facilities
- facilitate investment
- provide for the security of petroleum infrastructure
- promote competitive participation by historically disadvantaged South Africans in the petroleum pipeline industry by means of licence conditions
- promote the development of competitive markets
- promote access to affordable petroleum products
- ensure an appropriate supply of petroleum to meet market requirements.

Setting and approving tariffs, and facilitating third-party access to storage facilities are among the other objectives of the draft regulations.

They also deal with the lodging, acceptance and evaluation of construction and operating licences for petroleum pipelines.

A tariff-setting methodology, which is part of the regulations, will encourage investment in petroleum infrastructure.

Supply Task Team. It identified current and future supply constraints.

Possible strategies and options to deal with these issues include the need for investment by SOEs in pipelines, storage and handling facilities. The findings pointed to inefficiencies emanating from industry practices, especially in port and railway operations. Changes in the industry's operations are expected to result in rail-infrastructure capacity doubling and port capacity increasing.

PetroSA will invest in developing the requisite energy-infrastructure network. In 2006, the licensing of petroleum activities had started. All licences were expected to be issued by the end of 2007/08.

### Sasol

Sasol Limited is an innovative and competitive global energy company.

It is engaged in the commercial production and marketing of chemicals and liquid fuels, with a growing interest in oil and gas exploration.

Sasol was established in 1950 by the South African Government to manufacture fuels and chemicals from indigenous raw materials. The company has developed world-leading technology for the commercial production of synthetic fuels and chemicals from low-grade coal as well as the conversion of natural gas to environment-friendly fuels and chemicals. It is committed to sustainable development and is a signatory to Responsible Care, a worldwide initiative by the chemical industry that strives to improve performance in safety, health and environment.

About 30 000 workers drive the company forward in exploration, mining, science, technology R&D and business development. Sasol is listed on the Johannesburg Securities Exchange and the New York Stock Exchange.

### 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

South African Government's oil and gas assets and operations.

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. 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.

### Oil and gas

South Africa has very limited oil reserves and about 95% of its crude oil requirements are met by imports from the Middle East and Africa (Saudi Arabia, Iran, Kuwait, the United Arab Emirates, Yemen, Qatar, Iraq, Nigeria, Egypt and Angola).

Refined petroleum products such as petrol, diesel, residual fuel oil, paraffin, jet fuel, aviation gasoline, LPG and refinery gas are produced by the following methods:

- crude oil refining (oil refineries)
- coal to liquid fuels and gas to liquid fuels (Sasol)
- natural gas to liquid fuels (PetroSA)

The wholesale and retail markets for petroleum products in South Africa are subject to a set of

government controls. The Government regulates wholesale margins and controls the retail price of petrol. The industry has entered into product-exchange agreements to serve different markets. Together, these controls provide for access to fuel throughout the country and protect consumers, while providing a reasonable return on investment to the oil industry and enhancing opportunities for employment.

The refiners and wholesale marketers move products from the refineries by coastal barge, rail, truck and pipeline to roughly 200 depots. From these, about 4 600 service stations and 100 000 direct consumers (mostly farmers) are served.

Refineries and Sasol produce LPG and illuminating paraffin (kerosene). Most LPG is consumed in the country and the rest is used in refineries as fuel and/or exported regionally.

Limited natural gas reserves exist around the South African coast. PetroSA exploits the reserves off the coast of Mossel Bay, where the Moss gas plant converts the gas into liquid fuels.

Sasol produces gas from coal and is researching prospects to import gas from Namibia. Even though gas consumption has increased in recent years, the importance of gas in the South African energy economy is still low compared with other countries.

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

The importation of refined products is restricted to special cases where local producers cannot meet demand. It is subject to state control to promote local refinery usage.

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.

### **Biofuels**

The draft biofuels strategy was presented to Cabinet in 2006 and the final strategy was concluded by November 2007.

Pasa promotes the exploration for natural oil and gas resources.

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.

### **Cross-border gas trade agreement**

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 new 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. About 88% of South Africa's electricity is generated in coal-fired power stations. Koeberg, a large nuclear station near Cape Town, provides about 6,5% of capacity. A further 2,3% is provided by hydroelectric and pumped storage schemes.

In South Africa there are few, if any, new hydro sites that could be developed to deliver significant amounts of power, due to water scarcity. Eskom currently dominates electricity generation. This national SOE, which also owns and operates the national electricity grid, currently supplies about 95% of South Africa's electricity.

In global terms, the utility is among the top-10 in generating capacity, among the top-11 in terms of sales, and has one of the world's biggest dry-cooled power stations, namely 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.

Ever-increasing demand for electricity in an expanding economy has brought the era of excess capacity to an end. Eskom's net generating reserve margin is lower than the internationally accepted range of 15 to 18%.

Its power stations are ageing. In many cases, refurbishment is necessary to extend their economically useful life. Continued high-load factors at the stations (required to meet demand) put severe stress on all parts of the plant as they are frequently required to operate outside initial

design parameters. These loads require a high level of planned maintenance.

To meet these challenges, Eskom's previously approved R97-billion capacity expansion programme budget covering the five years to 2011 has been revised. One year on, the budget has been increased to R150 billion and covers the five years to 2012.

The Integrated National Electrification Programme (INEP) 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 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 High-Voltage Transmission System and supplies electricity directly to large consumers such as mines, mineral beneficiaries 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 (of approximately 750 MW) for KwaZulu-Natal, as part of a R150-billion expansion programme over the next five years. 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



In October 2007, PetroSA announced that it intended to build a R39-billion oil refinery in the Eastern Cape, with initial production of 200 000 barrels a day intended to start in 2014.

Construction of this project, which will create some 20 000 jobs, will start in 2010.

The project stems from South Africa's wish to reduce its growing economy's dependency on oil supplies from the Middle East and elsewhere.

PetroSA has interests in Nigeria and recently acquired exploration fields in Namibia, Mozambique, the Sudan and Egypt.

future electricity supply. The first step has been the reintroduction of three of its previously mothballed power stations.

These are Camden in Ermelo, Grootvlei in Balfour, and Komati, between Middelburg and Bethal. When fully operational by 2011, these stations should provide an additional 3 600 MW of capacity.

By mid-2007, the following progress was recorded:

- Camden: 1 580 MW – one unit was commissioned in 2006 (190 MW), and four units in 2007 (772 MW). The remaining 600 MW were expected to be commissioned by March 2008.
- Grootvlei: 1 200 MW – the first unit (200 MW) was expected to be commissioned at the end of 2007, with the balance to be commissioned by October 2009.
- Komati: 961 MW – due to be fully commissioned by 2011.

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

- continuing to strengthen the transmission system into the Cape (expected completion in 2007)
- strengthening the transmission network to the Coega Industrial Development Zone (IDZ) near Port Elizabeth, which is expected to be completed in 2009
- constructing a 765-KV line (200 km) from Majuba Power Station near Volksrust to KwaZulu-Natal, which is expected to be completed in 2009
- strengthening Johannesburg North to cater for load growth, including the high-speed Gautrain, which is expected to be completed in 2009

- integrating the new power stations with the transmission network.

In 2007, Nersa released an audit report conducted in 11 electricity-distribution utilities in the country. The report showed that the distribution industry's operations were suboptimal, with an infrastructure maintenance backlog of about R7 billion.

This scenario calls for the acceleration of the restructuring of the electricity distribution industry (EDI).

The EDI Restructuring Bill was expected to be presented to Parliament before the end of 2007. In October 2006, Cabinet decided to restructure the EDI into six wall-to-wall regional electricity distributors (Reds), as public entities managed through the Public Finance Management Act, 1999 (Act 1 of 1999), and regulated by Nersa.

By August 2007, EDI Holdings, together with the South African Local Government Association, was involved in an undertaking to re-establish Red1 in line with Cabinet's decision and the Regional Engagement Forum composed of Eskom and municipalities from the Western and Northern Cape, which was launched in July 2007.

In September 2007, Cabinet resolved that Eskom be designated as the single buyer of power from IPPs in South Africa.

Eskom will be responsible for ensuring that adequate generation capacity is made available and that 30% of the new power-generation capacity is derived from IPPs.

This policy will ensure that the responsibility and accountability for the construction of power-generation capacity is co-ordinated, and will provide more certainty to private providers.

The introduction of the private sector into the power-generation sector will also allow production-cost benchmarking with the state utility, thus ensuring that electricity is produced at the lowest possible cost.

Over the next 20 years, Eskom will build all nuclear power plants in South Africa while the IPPs will build more than 50% of all non-nuclear power plants.

The Department of Minerals and Energy will develop the Integrated Resource Plan that will define the magnitude of power-generating capacity needed to meet the country's electricity demands. Nersa will regulate the single-buyer function and specifically approve all commercial agreements between the single buyer and the private producers.

Institutional and regulatory mechanisms will be put in place as per the Electricity Regulation Act, 2006 (Act 4 of 2006).

## **Integrated National Electrification Programme**

The INEP remains the flagship of the Department of Minerals and Energy. Eskom is responsible for implementing the programme in its licensed areas of supply on the department's behalf.

Eskom continues to exceed its electrification targets. The target for 2006 was 141 578 connections but the actual number connected was 152 125. By mid-2007, since the inception of the electrification programme in 1991, 3 469 650 homes had been electrified, including subsequent in-fill connections.

The Electricity Basic Services Support Tariff 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 and municipalities are the service-providers for free basic electricity in their respective areas of supply.

The electricity meters of a further 1 181 823 customers were reconfigured to receive free basic electricity (1 254 199 in 2006) and almost total coverage of municipalities had been achieved by June 2007, bringing relief to low-income households.

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

Although these users have access to a basic quantity of 50 KWh per household per month in terms of the policy, they 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.

Of the R1,4 billion allocated for household electrification, a further R380 million was set aside for the building of 10 substations. Some 150 000 households and 700 schools were expected to be connected in 2007.

The backlog at clinics was expected to be eradicated by the end of 2007/08, and at schools within three years.

### National Energy Regulator of South Africa

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; 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 NER has regulated the electricity industry for the past 10 years, the piped-gas and petroleum-pipeline industries in South Africa are now regulated for the first time. Three industries fund Nersa 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.

The Electricity Regulation Amendment Bill will ensure that Nersa plays an unambiguous role in its quest to achieve better regulation outcomes in the entire electricity value chain.

### National and regional co-operation

Nersa, represented by its chief executive officer, was elected as chair of the African Forum for Utility Regulators (Afur) from 2006 to 2009.

The Afur focuses on issues related to the regulation of energy, telecommunications, transport, and water and sanitation industries, with particular emphasis on common issues. Afur is regarded as a key building block in the African Union's efforts and its socio-economic programme, Nepad, in the integration and rebirth of Africa. Afur's vision and objectives are derived from Clause 110 of the Nepad Framework Document, which recognises the establishment of the Afur and regional regulatory associations. Afur operates as a formal association of African regulators, with its own constitution stipulating its objectives, functions and other operational requirements.

Afur's objectives entail supporting the development of effective utility regulation in Africa by facilitating the harmonisation of regulatory policies, exchange of information and lessons of

experience among regulators, and capacity-building in support of the socio-economic development of the continent.

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.

### Southern African Power Pool (SAPP)

The SAPP is the first formal 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

Renewable energy comprises biomass and natural processes that are replenished and can be used as an energy source. Biomass is used commercially in pulp and paper mills and sugar refineries by

burning bulk from logs, black liquor and bagasse to produce process heat. The energy produced is used by those industries to meet their needs.

In future, some of this energy could be sold to the national grid (depending on electricity prices and environmental regulations). However, given the limited potential for agricultural expansion due to a lack of water and arable land, it is unlikely that this could make a major contribution.

In households, biomass is used for cooking and heating. Biomass is estimated to comprise 8% of South Africa's primary energy supply.

## 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 and promote 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 compared 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
- 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.

In October 2005, the Renewable Energy Finance and Subsidy Office's website – [www.dme.gov.za/dme/energy/refso.htm](http://www.dme.gov.za/dme/energy/refso.htm) – was established. It is useful for providing information and application forms to potential applicants.

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.

Eskom's Renewable Energy Strategy states a commitment to increase the share of renewable energy in Eskom's energy mix. The aspiration is to include 1 600 MW of renewable energy in the mix by 2025.

Eskom has also partnered with the World Wildlife Fund South Africa to develop a renewable energy research fund for renewable energy projects outside Eskom. Eskom has committed R3 million to the fund over three years.

## Solar

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

The southern African region, and in fact the whole of Africa, is well endowed with sunshine all year round. The annual 24-hour global solar radiation average is about 220 W/m<sup>2</sup> for South Africa, compared with about 150 W/m<sup>2</sup> for parts of the USA, and about 100 W/m<sup>2</sup> for Europe and the United Kingdom. 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.

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

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

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 with energy-consumption or energy-efficiency in mind. The energy characteristics of low-cost housing are particularly bad, resulting in energy consumption for heating homes 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 made "energy smart" by using elementary "solar-passive building design" practice. This could result in fuel savings of as much as 65%, which could significantly benefit households' energy costs. 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 average household's energy consumption. 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.

### **Solar-thermal power generation**

The minimum direct normal radiation (DNR) to justify a combined solar-thermal power plant is 1 800 kWh/m<sup>2</sup> per year. According to the Renewable Energy Resource Database, the area exceeding the minimum required DNR in South Africa covers about 194 000 km<sup>2</sup>. A 100-MW solar-thermal plant requires roughly 3 km<sup>2</sup> (1 800 kWh/m<sup>2</sup> per year).

If 1% (1 940 km<sup>2</sup>) of the identified area is available for solar-thermal power generation, 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 investigating the feasibility of a 100-MW CSP plant in the Northern Cape. This would provide energy for use during times of greater demand.

A prototype heliostat (large two-axis mirrors), one of the key components, has been installed at Eskom's R&D facility. By mid-2007, the EIA was nearing completion, discussions with technology partners had been initiated and a draft project plan completed.

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

The CSP plant being considered has molten salt-type central-receiver technology, which is based on the concept of thousands of large heliostats tracking the sun and reflecting 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. During that time, the Klipheuwel pilot wind farm generated more than 12 GWh of electricity, thus reducing carbon dioxide emissions by 11 000 t. The three wind turbines operated at an average availability of 90%. The project's research phase has been completed and this pilot wind farm will be operated commercially for its anticipated 20-year lifespan as calculated from 2006.

Pending approvals and licensing processes, Eskom has decided to build a 100-MW wind facility. The choice of location and technology to be used is based on information obtained from the Klipheuwel pilot wind 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 make 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 is expected to feed the national power grid by using four giant wind turbines to generate an estimated 13,2 GW/h of "clean" electricity a 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-t 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 developing all categories of hydropower in the short and medium term.

The Eastern Cape and KwaZulu-Natal are endowed with the best potential for developing 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 Ingula 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 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.

The SAPP allows for 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 memorandum of understanding 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 Highlands 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 could be converted into hydraulic pressure by mechanical compression devices.

Such pressure could drive a turbine generator to produce electricity, while the tidal variation, sea current and different thermal layers in the ocean could 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 established.

Eskom has continued with resource surveys of the Agulhas current on the east coast of South Africa and of wave energy, in partnership with Marine and Coastal Management, and the Bayworld Centre for Research and Education.

By mid-2007, results had proved the technical feasibility of extracting significant large-scale renewable energy from the current.

## Energy and the environment

### Energy and the global environment

South Africa is among the top-20 emitters of GHGs in the world and is the largest emitter in Africa, largely because of the economy's dependence on fossil fuels. The National Climate Change Strategy, developed by the Department of Environmental Affairs and Tourism, requires that government departments collaborate in a co-ordinated manner to ensure that response measures to climate change are properly directed and carried out with a national focus. The Department of Minerals and Energy is expected to respond and mitigate climate change.

South Africa is a developing country or a non-annex1 country. This means that within the international political and negotiation context, South Africa is not required to reduce its GHG emissions. However, the South African economy depends greatly on fossil fuels for energy generation and consumption and therefore is a significant emitter due to relatively high values being derived from emissions intensity and emissions per capita. These calculations make South Africa one of the top-15 most energy-intensive economies that contribute significantly to GHG emissions.

Therefore, South Africa must proactively move the economy towards becoming less carbon-intensive, with the Department of Minerals and Energy playing a prominent role. The department has introduced systems to access investment through the CDM of the Kyoto Protocol. It has developed the *White Paper on Renewable Energy and Clean Energy Development*, together with an energy-efficiency programme, to support diversification in pursuit of a less carbon-intensive energy economy.

### Sources of greenhouse gas emissions

The energy sector is a major source of GHGs, because of South Africa's 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.

The reduction of particulate emissions from Eskom coal-fired power stations has been the most significant environmental challenge the organisation has faced. Particulate reduction began in the 1980s. Initial reductions followed the mothballing and closure of many of the older plants. From the early 1990s, reductions were achieved by installing bag-filters and managing electrostatic precipitators better. In the late 1990s,

Eskom developed a stringent five-year target to cut particulate emissions from an average of 0,37 kg/MWh to 0,28 kg/MWh.

Between 1990 and 2003, total annual particulate emissions were reduced from 271 000 t to 57 000 t, while the energy delivered increased by 64 000 GWh.

### Energy and the national environment

There is some contention regarding the polluting effects of the energy sector, particularly in the Mpumalanga Highveld, where most of Eskom's coal-powered stations and the largest Sasol plants are located.

Eskom has announced a much higher proportion of nuclear energy as part of the future energy mix by 2025.

### 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<sup>3</sup>) by factors of six to seven during winter, and two to three in summer. A national programme has been established to introduce low-smoke energy alternatives into the townships.

Fuel wood is used by millions of 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.

By November 2007, about 3,5 million households did not have access to electricity and relied primarily on paraffin and collected wood for light, cooking and heating.

The *White Paper on Clean and Renewable Energy* commits South Africa to producing 5% of the country's energy supply from renewable energy sources by 2013.

One way of doing this and simultaneously dealing with South Africa's electricity infrastructure pressures, is to have more energy-efficient houses that use the sun's free energy. The Department of Science and Technology, the Overstrand Municipality and the Cape Town Grail Centre Trust are collaborating on a sustainable development project involving the construction of more than 600 low-cost houses that will use building material offering better insulation, and have solar water-heaters. The project is also looking at ways of catching storm water to irrigate the local school's sports field and will pilot a novel reed-bed sewerage treatment plant.

Projects of this nature could yield useful lessons and technologies to support the Department of Housing in its shift towards environmentally sustainable housing projects.

In the search for energy solutions, the department's work on Hydrogen Fuel Cells continues.

### Designated National Authority (DNA)

The South African DNA was established in December 2004 as an important step towards the implementing the provisions of the Kyoto Protocol and of the United Nations Framework Convention on Climate Change (UNFCCC).

The main functions of the DNA are to regulate and promote CDM activities in South Africa. In its evaluation process, the DNA uses an established approval procedure and criteria that look at the projects' social, economical and environmental contribution.

According to the Department of Minerals and Energy, the Kyoto Protocol's CDM makes it possible to trade emission reductions on international carbon markets, for example, by improving energy efficiency in industry, recovering methane from landfill sites, or by switching to renewable energy sources. The CDM is the market mechanism designed to assist developing countries to stimulate the green investment required to tackle climate change and become a low-carbon economy. The CDM, even with its current limitations, provides an effective vehicle for developing countries to participate in ongoing efforts to reduce carbon emissions, achieve



In March 2007, the Solar Water Heater (SWH) Test Rig was launched at the South African Bureau of Standards in Pretoria.

The SWH Test Rig is the first of its kind in Africa and has the potential to leverage electricity savings, increase employment opportunities, improve management of electricity demand and reduce greenhouse gas emissions.

technological progress and promote sustainable development.

By 31 March 2007, South Africa had received and reviewed 46 CDM projects. Seven were at advanced project implementation stages and 12 had been recognised and registered as South African CDM projects by the CDM Executive Board of the UNFCCC. By June 2007, South Africa had nine registered projects with another 39 to come.

These projects could contribute to government's sustainable development objectives of alleviating poverty and creating jobs, accessing clean energy, technology transfer and economic development. These projects could also help South Africa reduce GHGs such as CO<sub>2</sub>, which is emitted largely by the energy sector. The project types reviewed by November 2007, were in the energy sector i.e fuel switching, cogeneration, renewable-energy generation, and energy efficiency. Collectively, these projects' lifespan will reduce about 24 Mt of CO<sub>2</sub> equivalent yearly, and contribute about 58 MW through electricity generation and energy savings.

### 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, as well as several greenstone belts, being preserved. 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 south of Nelspruit, Mpumalanga. The renowned Barberton



Greenstone Belt, the largest of its kind in South Africa, contains remnants of original crust, dated at 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.

Granites surround the formations and gneisses that are more than 3 000 million years old.

Gold, iron ore, magnesite, talc, barite, chrysotile asbestos and verditite 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 Johannesburg's 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 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 km<sup>2</sup> 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. 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 are in this area.

The Great Escarpment of Mpumalanga 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 were formed by the partial erosion of a high 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 about two thirds 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 form 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” that continued to yield diamonds was encountered.

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 partial 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.

About 40 km north of Pretoria is a small bowl-shaped meteorite-impact crater, termed Tswaing. Just one kilometre in diameter, this is one of the best-preserved and accessible impact craters of its kind on Earth. It was created about 220 000 years ago when a meteorite of about 50 m wide slammed into the Earth, and is one of the few impact craters containing a crater lake.

### **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 volcanic breccias can be seen.

The dominant feature of the complex is the concentric cone sheets formed by resurgent magma that intruded ring fractures, created during the collapse of the volcano.

There are old mining sites for fluorite and dimension stone, and a non-diamond-bearing kimberlite pipe in the region.

Pilanesberg is also the site of a magnificent game reserve containing the Big Five and the world-renowned Palace of the Lost City hotel complex and golf course.

### **Cradle of Humankind**

This world heritage site extends from the Witwatersrand in the south to the Magaliesberg in the north, and is considered to be of universal value because of the outstanding richness of its fossil hominid cave sites.

The Sterkfontein area near Krugersdorp is 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 material.

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

Table Mountain is, arguably, South Africa's best known and most spectacular geological feature, comprising a number of 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,

which started forming about 450 million years ago, consists of basalt, 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 adjacent to Table Mountain. The Table Mountain Group continues further inland across False Bay in the strongly deformed Cape Fold Belt.

## Acknowledgements

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*Digest of South African Energy Statistics – 2006* – published by the Department of Minerals and Energy  
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## Suggested reading

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