



Energy



**SOUTH
AFRICA**
YEARBOOK
2011/12

Energy use in South Africa is characterised by a high level of dependence on cheap and abundantly available coal. South Africa imports a large amount of crude oil. A limited quantity of natural gas is also available.

The country also mines uranium, which is exported, and imports enriched uranium for its nuclear power plant, Koeberg. South Africa uses renewable energy in the form of electricity generated by hydropower, most of which is imported.

Electricity is also generated from other renewable energy sources, mainly biomass and to a lesser extent solar and wind energy.

The Government intends to diversify energy supply and is promoting the use of renewable energy technology and other new energy technologies. In addition, it aims to improve energy efficiency throughout the economy.

The energy sector is critical to South Africa's economy, contributing about 15% to the country's gross domestic product.

The Department of Energy is responsible for ensuring exploration, development, processing, use and management of South Africa's energy resources. As the country's economy continues to grow, energy is increasingly becoming a key focus.

Over the past 20 years, South Africa has not made significant investments in the energy sector. The capacity that was created in the 1980s was sufficient to carry the country through to the early 2000s, when it became clear that growth, fuelled by the commodity boom, outpaced power supply and that there was an urgent need to increase it.

Government has implemented a planning framework for the energy sector, anchored by the Integrated Energy Plan (IEP) and the Integrated Resource Plan (IRP), as the instruments to drive government's set objectives over and above supply adequacy. Issues such as job creation, reducing greenhouse-gas (GHG) emissions, and alignment with the New Growth Path and Government's Programme of Action, will be an integral part of this strategic plan over the next few years.

Government further aims to achieve 92% distribution penetration in accessing the electricity distribution grid by 2014.

For government to attain this objective, the Department of Energy has to ensure that the old electricity distribution infrastructure in municipalities is stable and sustainable. The financial impact of this on electricity-distributing municipalities will be large. The distribution of

electricity by municipalities is driven by political and social responsibility that ensures that tariff increases do not affect the poorest of the poor. This is achieved by employing an indigent policy and block tariffs to ensure the electrification of every household and supply of energy.

The strategic economic policy identifies energy as one of the drivers for economic growth, a sustainable environment and the supply of clean energy. As part of this, government hosted the United Nations (UN) Framework Convention on Climate Change Conference of the Parties (COP17), with the aim of brainstorming climate change and the use of green energy as a mechanism for job creation, the reduction of carbon emissions and to take advantage of the technological developments in the industry.

The strategic objectives of the Department of Energy expressed as desired end-states are:

- a secure energy supply and well-managed demand
- an efficient, competitive and responsive energy infrastructure network
- improved energy regulation and competition
- an efficient and diverse energy mix for universal access within a transformed energy sector
- environmental assets and natural resources being protected and continually enhanced by cleaner energy technologies
- mitigation against, and adaptation to, the impacts of climate change
- good corporate governance for effective and efficient service delivery.

The Minister of Energy is responsible for overseeing five state-owned enterprises (SOEs) and their subsidiaries, which are either classified as Schedule 2 or 3 institutions in the Public Finance Management Act, 1999 (Act 1 of 1999). They are the National Nuclear Regulator (NNR), the Central Energy Fund (CEF) group of companies under CEF (Pty) Ltd, the South African Nuclear Energy Corporation (Necsa), the National Energy Regulator of South Africa (Nersa) and the South African National Energy Development Institute (Sanedi).

The department is represented on all of these enterprises' boards, with the exception of Nersa, which is independent. The closing process of Electricity Distribution Industry Holdings (EDIH), another SOE in the Department of Energy's stable, was completed in 2011/12 as per the Cabinet decision in December 2010 on the future of the electricity distribution industry.

President Jacob Zuma co-signed a performance agreement with the Minister of Energy, Ms Dipuo Peters, in April 2010 that, together with the associated delivery agreements, initiates government's new outcomes-based approach as it relates to energy.

The Department of Energy will primarily contribute to three of the 12 priority outcomes referred to as the Change Agenda, namely decent employment through inclusive growth (Outcome 4); an efficient, competitive and responsive economic infrastructure network (Outcome 6); and environmental assets and natural resources that are protected and continually enhanced (Outcome 10); and, to a lesser extent, to the remaining nine expected outcomes. At the same time, the department will continue to deliver on its core mandate, also termed the Sustained Agenda.

The department aims to introduce independent power producers (IPPs) in the electricity space. Unserved communities' access to electricity through the Integrated National Electrification Programme (INEP) will continue to be funded through the Department of Energy.

Energy demand-side management (DSM) remains important over the medium term, although the funding mechanism will change to the standardised offer model, which will enable more and newer technologies to enter the energy-efficiency market.

South Africa has committed to substantial reductions in carbon dioxide emissions by 2025 and supports research and technology development aimed at environmentally sustainable economic growth.

Government will focus on improving biodiversity protection.

Legislation **National Energy Act, 2008** **(Act 34 of 2008)**

The National Energy Act, 2008 empowers the Minister of Energy to ensure that diverse energy resources are available in sustainable quantities and at affordable prices in South Africa. This supports economic growth and poverty alleviation, while also taking into account environmental considerations. In addition, the Act provides for the increased use of renewable energies, contingency energy supplies, the holding of strategic energy feedstock and carriers, and adequate investment in energy infrastructure.

The Department of Energy is mandated to provide for energy planning and measures for the provision of certain data and information regarding energy demand, supply and generation.

Electricity Regulation Amendment Act, 2007 (Act 27 of 2007)

The Electricity Regulation Act, 2007 establishes a national regulatory framework for the electricity supply industry to be enforced by Nersa. The Minister of Energy, in terms of Section 34 (1), is empowered to make determinations for the establishment of IPPs for the purpose of greater competition in the electricity generation sector to increase electricity supply.

Petroleum Products Act, 1977 **(Act 120 of 1977)**

The Act provides for measures in the saving of petroleum products and the economy in the cost of distribution, and for the maintenance and control of price.

It also provides for the furnishing of certain information regarding petroleum products and for the rendering of service of a particular kind or service of a particular standard in connection with petroleum products.

The Act further provides for the licensing of persons involved in the manufacturing, wholesaling and retailing of prescribed petroleum products, to promote the transformation of the South African petroleum and liquid fuels industry and to provide for the promulgation of regulations relating to such licences.

Central Energy Fund Act, 1977 (Act 38 of 1977)

The Act provides for the determination of state levies.

Nuclear energy

Following the *White Paper on the Energy Policy of the Republic of South Africa, 1998*, the Nuclear Energy Policy was approved by Cabinet in June 2008. The policy provides a framework within which prospecting, mining, milling and the use of nuclear material as well as the development and use of nuclear energy for peaceful purposes will take place.

The long-term vision of the policy is for South Africa to become globally competitive in the use of innovative technology for the design, manufac-

ture and deployment of state-of-the-art nuclear energy systems and power reactors, and nuclear fuel-cycle systems.

The Department of Energy is also planning to review and update the *White Paper on the Energy Policy of the Republic of South Africa* during the Medium Term Expenditure Framework (MTEF) 2011 to 2014.

Nuclear energy is governed by the following primary pieces of legislation: Nuclear Energy Act, 1999 (Act 46 of 1999), the NNR Act, 1999 (Act 47 of 1999), and the National Radioactive Waste Disposal Institute Act, 2008 (Act 53 of 2008).

Other legislative mandates

Other mandates in the field include:

- CEF Amendment Act, 1994 (Act 48 of 1994)
- Petroleum Pipelines Act, 2003 (Act 60 of 2003)
- Gas Act, 2001 (Act 48 of 2001)
- Gas Regulator Levies Act, 2002 (Act 75 of 2002)
- Petroleum Pipelines Levies Act, 2004 (Act 28 of 2004)
- National Energy Regulator Act, 2004 (Act 40 of 2004).

The Department of Energy derives its mandate from the *White Paper on the Energy Policy of the Republic of South Africa*. The department is responsible for ensuring energy security within the country. It does this by undertaking IEP, regulating energy industries and promoting electric power investment in accordance with the IRP. The Department of Energy also continues to implement the Electricity Regulation Amendment Act, 2007, especially with respect to creating the necessary conditions for the introduction of an independent systems operator and IPPs in the electricity market.

The recommendations made in the Energy Security Master Plan for Liquid Fuels, approved by Cabinet in 2007, continue to be implemented, with the focus primarily on addressing short- to medium-term infrastructural constraints within the liquid fuels sector.

Integrated Resource Plan for Energy

The IRP is a subset of the IEP. It directs the expansion of the electricity supply over the given period. Its purpose is the identification of the requisite investments in the electricity sector that maximise the national interest; and investments

in the electricity sector that allow the country to meet the forecast demand with the minimum cost to the country.

The IRP lays the foundation for the country's energy mix up to 2030, and seeks to find an appropriate balance between the expectations of different stakeholders, considering a number of key constraints and risks, including:

- reducing carbon emissions
- new technology uncertainties such as costs, operability and lead time to build
- water use
- localisation and job creation
- southern African regional development and integration
- security of supply.

The IRP provides for a diversified energy mix, in terms of new-generation capacity, that will comprise:

- coal at 14% (government's view is that there is a future for coal in the energy mix, and that it should continue research and development [R&D] to find ways to clean the country's abundant coal resources)
- nuclear at 22,6%
- open-cycle gas turbine at 9,2% and closed-cycle gas turbine at 5,6%
- renewable energy carriers, which include hydro at 6,1%, wind at 19,7%, concentrated solar power (CSP) at 2,4% and photovoltaic (PV) at 19,7%.

Policy initiatives Ensuring energy security

In 2011, the department was working on an Integrated Energy Planning Strategy. The

In December 2011, South Africa released its first list of preferred independent power producers (IPPs), accepting 28 bids from companies to generate over 1 400 MW of electricity from solar and wind sources. The announcement was made on the sidelines of the United Nations Climate Change Conference in Durban.

The Department of Energy put out a request for proposals on new-generation energy in August 2011, asking IPPs to submit their proposals for the first window, which closed on 4 November.

According to the Government's Integrated Resource Plan, a 20-year projection on electricity supply and demand, about 42% of electricity generated in the country – about 3 725 MW – is required to come from renewable resources.

From Phase One of the large-scale renewable project, 53 bids amounting to 2 128 MW were received across wind, photovoltaic solar power, concentrated solar power and small hydro-electric projects.

strategy is expected to outline the requisite processes, systems and structures that will lead to the development of a comprehensive IEP.

National Strategic Fuels Stock Policy

The Energy Security Master Plan for Liquid Fuel identified a number of capacity constraints and challenges faced by the petroleum sector in meeting the energy demand. In response to these, the National Strategic Fuels Stock Policy was expected to be submitted to Cabinet during 2011/12. It will set the framework for the storage of fuel stock by government and the industry. It also seeks to guide the necessary investment decisions within the liquid-fuels sector to ensure the security of energy supply. Towards the end of September 2010, the department drafted and published regulations in respect of strategic stocks to be kept by oil companies, which was expected to be finalised during 2011/12.

National Liquid Petroleum Gas (LPG) Strategy

As part of the promotion of clean energy sources, the department drafted the LPG Strategy, which was submitted to Cabinet in 2011/12. The strategy's main objectives are to provide access to safe, cleaner, efficient, portable, environmentally friendly and affordable thermal fuel for all households, and to switch low-income households away from the use of coal, paraffin and biomass to LPG.

Cleaner Fuels Programme

To improve the quality of transport fuels, the department reviewed the fuel specifications and standards to reduce harmful emissions, and to align standards with global vehicle-technology trends and environmental requirements. This is expected to encourage vehicle manufacturers to introduce more fuel-efficient engine technologies with lower carbon and noxious gas emissions. The department drafted a position paper for consultation and intended to announce new fuel specifications in 2011/12.

Promoting clean and renewable energy resources

Promoting the development and use of clean and renewable energy resources remains a priority for the Department of Energy. Renewable energy

feed-in tariffs have been set for a diverse portfolio of renewable energy sources, including wind, solar, biomass and small-scale hydro. Producers who invest in renewable energy are encouraged by tariffs that cover the cost of generation plus an attractive return.

Similarly, energy-efficiency programmes are prioritised and the department has developed a solar water-heating framework, which consolidates all solar water-heating programmes run by various municipalities, public entities and the private sector. A standard offer framework, which provides incentives for interventions that improve energy efficiency in the domestic, industrial and commercial sectors, was developed and expected to be finalised in 2011/12.

These initiatives assist the department to achieve its target of producing 10 000 GWh of electricity from renewable sources by 2013, and to improve energy efficiency by 12% by 2015.

Independent power producers

The department will initiate a procurement process for renewable energy investment under the Renewable Energy Feed-In Tariff (Refit) Programme. Technologies, including solar, wind, biomass, hydro and landfill gas, will form part of a diversified portfolio of renewable energy. In addition to the renewable-energy IPPs, other non-Eskom generation opportunities will be procured, particularly co-generation and other options identified as part of the IRP implementation process.

In August 2011, the chairperson of the Infrastructure Development Cluster and Minister of Transport, Mr Sibusiso Ndebele, announced that five contracts had been signed with IPPs, adding 373 MW of electricity to the national grid, as part of the initiative to supplement Eskom's electricity generation capacity.

Infrastructure rehabilitation

It has become critical to address the problems facing the electricity distribution network, particularly municipal infrastructure. The Approach to Distribution Asset Management Programme is expected to rehabilitate identified municipal structures that pose a risk to energy security.

Funding

The department has been allocated R15,9 billion over the MTEF period, with an allocation of R6,09 billion for 2011/12.

Of the 2011/12 budget, 95% (R5,78 billion) was transferred to the following:

- INEP: R3,2 billion for distribution to municipalities and Eskom, to continue with electrification and the non-grid programme
- Necsa: R586 million to continue with its central role as the anchor for nuclear energy R&D and innovation
- energy efficiency and demand-side management (DSM): R398 million for DSM interventions in 21 municipalities and through Eskom
- Transnet: R375 million quarterly.

Public entities and other role players

National Energy Regulator of South Africa

Nersa regulates electricity (in terms of the Electricity Regulation Act, 2006), gas (in terms of the Gas Act, 2001) and petroleum pipelines (in terms of Petroleum Pipelines Act, 2003).

Nersa adopted high-level strategic objectives over the next few years, namely:

- creating regulatory certainty in the energy sector
- protecting the interests of the public and customers
- creating dispensation for fair competition for industry players
- creating energy supply certainty
- creating an effective organisation that delivers on its mandate and purpose.

The total budgeted income for 2011/12 was R223,022 million.

National Nuclear Regulator

The purpose of the NNR is to provide for the protection of persons, property and the environment against nuclear damage, through the establishment of safety standards and regulatory practices.

Strategic objectives to be pursued entail:

- optimising the regulatory framework
- creating a high-quality performance and service culture
- promoting good governance
- developing and maintaining sound organisational infrastructure
- developing a financially viable and sustainable funding model
- managing talent and knowledge
- enhancing stakeholder relations.

The budget for 2011/12 was R149,751 million, of which R103,435 million was funded from fees

paid by authorisation holders, and the balance from the State.

Nuclear Energy Corporation of South Africa

Necsa was established as a public company in terms of the Nuclear Energy Act, 1999 and is wholly owned by the State.

The Act provides for the commercialisation of nuclear and related products and services, and delegates specific responsibilities to the corporation, including the implementation and execution of national safeguards and other international obligations. The Nuclear Energy Policy of 2008 elaborated on Necsa's mandate relating to R&D and nuclear fuel-cycle responsibilities.

The corporation's main function is to serve as the anchor for nuclear energy R&D and innovation in South Africa. The strong research focus is directed mainly at nuclear technology applications, particularly relating to:

- the production of medical isotopes
- applied chemistry with an emphasis on uranium chemistry
- the application of radiation and nuclear technologies
- aspects of the nuclear fuel cycle (including waste).

The corporation is also responsible for operating the Safari-1 research reactor to undertake nuclear science R&D and to provide irradiation services for the production of medical radioisotopes; decommissioning and decontaminating nuclear facilities; and implementing the Nuclear Non-Proliferation Treaty and the Comprehensive Safeguards Agreement with the International Atomic Energy Agency, the Africa Regional Cooperative Agreement for Research, Development and Training related to Nuclear Science and Technology; and the Pelindaba Treaty.

Over the MTEF, the corporation will focus on:

- radiation research, products and services
- nuclear fuel R&D in relation to low enriched uranium research-reactor production facilities
- nuclear-component manufacturing to support future nuclear programmes and future power reactors
- contributing to higher industrial manufacturing standards and sustainable job creation.

Necsa's products and service offerings are delivered through three main programme clusters, namely:

- the Nuclear Power Cluster, which undertakes nuclear fuel development and production, and projects and services in support of South Africa's Nuclear Power Programme
- the Radiation Science and Applications Cluster, which delivers radiation-sciences research services, and develops products and services for the industry, including isotopes for the medical sector
- the Necsa as Host of Nuclear Programmes Cluster, which refers to Necsa's services to house nuclear programmes due to its unique integrated system, licensed nuclear infrastructure and specialised supporting services.

Necsa has a nuclear science centre where members of the public can learn more about nuclear energy.

Recognising the need for skills for nuclear expansion, Necsa, with the support of the Department of Trade and Industry, invests in artisan skills.

South African National Energy Development Institute

Sanedi (previously Saneri) was restructured during the MTEF.

The original institute's aims were to stimulate innovation in energy R&D, transform the gender and race profile of researchers in the sector, and improve South Africa's competitiveness in energy research internationally. This was done by procuring research, facilitating cooperation with others in the research community and commercialising innovations achieved under its auspices by disseminating R&D results and, if required, conducting its own research programmes. It also provided support to postgraduate research students, promoted career development and assisted internationally renowned researchers to return to or remain in South Africa.

With the restructuring process, the institute's aims were expanded to also promote energy-efficiency initiatives and DSM. Sanedi will house South Africa's carbon capture and storage R&D, and other energy research programmes.

Sanedi's budget for 2011/12 was R20,1 million.

Central Energy Fund

The CEF is a private company, governed by the CEF Act, 1977. It researches, finances, develops and exploits appropriate energy solutions across the spectrum of energy sources to meet South Africa's future energy needs. It is also mandated

The Nuclear Energy Corporation of South Africa continues to produce, through its subsidiary, the National Toxicology Programme, radioisotopes that are critical to diagnose and treat cancer. They have become the leading commercial supplier of medical radioisotopes that are produced from low-enriched uranium as opposed to nuclear weapons-grade uranium.

to manage the Equalisation Fund, which collects levies from the retail sales of petroleum products to eliminate unnecessary fluctuations in the retail price of liquid fuel and to give tariff protection to the synthetic fuel industry.

The objectives of the CEF are:

- managing the energy business for the benefit of all South Africans
- playing an active role in the governance and planning of all its subsidiaries and coordinating the long-term future of the group
- improving energy security of supply by diversifying sources, and building and managing strategic energy stocks and energy infrastructure
- developing and investing in renewable and alternative energy sources and in energy efficiency
- developing human capacity and investing in relevant R&D
- managing and optimally exploiting local strategic energy and related resources
- mitigating against environmental impacts and maximising sustainable development.

The group's total operating costs for 2010/11 amounted to R11,283 billion.

Integrated energy centres (IECs)

The IECs Programme is one of the initiatives the department has adopted to contribute to rural development and job creation in the fight against energy poverty.

Sasol supported the drive to commemorate the 20th anniversary of the release of former President Nelson Mandela by establishing an IEC at Qunu in Eastern Cape.

The department is also working with the Department of Rural Development and Land Reform to develop future IECs in line with the Comprehensive Rural Development Programme. The two departments conducted an energy needs assessment in Muyexe Village in Giyani, Limpopo.

In 2011, the department launched a further two IECs, funded by PetroSA, the national oil company of South Africa.

Energy efficiency

Government has set a target of 15% energy efficiency for the industry and 12% nationally to be achieved by 2015.

The objective of the Energy-Efficiency Campaign is to raise and enhance awareness of the benefits of efficient use of energy to all stakeholders, while simultaneously increasing the flow of energy-efficient information. There are other components of the campaign that involve partnership with other key role players such as government, the business community, Sanedi, the UN Development Programme (Unido) and the Swiss Development Corporation.

The Industrial Energy-Efficiency Programme will provide capacity-building among employees in the industry. It is an initiative between government, business and Unido. Its main objectives are skills transfer and technical support in the intensive roll-out of optimised energy systems in industry, and the implementation of sound energy-management practices.

In the building sector especially, it is necessary to raise awareness of the importance of energy efficiency and the market profile of a building's energy performance, while ensuring that energy efficiency in buildings is visible. It is also important to provide information on major energy-saving opportunities to all in the building sector. The national building codes and regulations also addressed energy efficiency as one of its components for enforcement.

National Treasury has set in place tax incentive regulations for companies within the energy-efficient value chain, which are expected to come into force once the energy-efficiency regulations are completed.

The Energy-Efficiency Monitoring System is a collaboration between government, through the Department of Energy and the Swiss Development Corporation. The programme aims to ensure that energy-efficient policies are supported by adequate end-use information systems, by substantially increasing the effort to collect data about energy efficiency and information across all sectors.

Another way government aims to encourage energy efficiency is through local government initiatives, led by the South African Local Government Association. Five municipalities have been selected to pilot the Energy-Efficiency Campaign: Sol Plaatje, Polokwane, Rustenburg, King Sabata Dalindyebo and Mbombela. Among other projects,

the installation of one million solar water heaters by 2014 is underway in these municipalities.

The energy sector accounts for a large percentage of CO₂ emissions, which directly contribute to climate change. It is imperative that government implement practices that will reduce demand, choose cleaner resources and deploy the best available energy technologies, while also creating jobs.

Over the past few years, standards have been developed to enhance the Energy-Efficient Appliance Labelling Programme. By August 2011, they were very close to publication, and entail methods of measuring the power consumption of audio, video and related appliances; household electrical appliances – the measurement of standby power; and methods for measuring the energy efficiency of electrical lamps for household use.

Carbon capture and storage roadmap

Although South Africa has a programme to increase the use of renewable energy and energy efficiency, coal is likely to provide most of the country's primary energy for the next few decades.

The displacement of fossil fuels by renewable and nuclear energy is seen as a gradual task. Carbon capture and storage is a transition measure from fossil fuel to nuclear and renewable energy. To this end, the South African Centre for Carbon Capture and Storage was established in March 2009.

The five phases of the roadmap and their status are as follows:

- A preliminary investigation was undertaken by the Council for Scientific and Industrial Research for the then Department of Minerals and Energy to ascertain whether South Africa had potential capturable carbon-dioxide sources and storage sites. The results of that investigation, released in 2004, showed that South Africa had capturable emissions and potential storage sites. Based on this premise, further investigations were initiated. The preliminary investigation also identified that the synfuel industry in South Africa produced 30 million tons (Mt) per year of 95% concentration carbon dioxide.
- The *Carbon Dioxide Geological Storage Atlas* (launched in August 2010) will locate and characterise potential storage sites at a theoretical level and on a geological basin extent. The

atlas will then be taken into the South African Centre for Carbon Capture and Storage's programme of work and be developed to locate a storage site suitable for a test injection. Pre-atlas knowledge had identified four possible carbon-dioxide geological storage basins:

- Orange Basin (off-shore of the west coast)
- Outeniqua Basin (off-shore of the southern coastline and site of the only producing gas/petroleum wells in South Africa)
- Durban/Zululand Basin (east coast)
- Karoo On-Shore Basin (near the main coal-fields and most coal-based electricity generation and synfuel production).

The first three are conventional types of storage – that is depleted oil/gas wells and deep saline formations. The fourth, the Karoo Basin, has sandstone formations that are subject to low permeability and also to dolerite intrusions. Consequently, further investigation is required as to how carbon dioxide could be stored in these less favourable formations. The Karoo Basin is the closest to the current major sources of carbon dioxide emissions.

- The CO₂ Test Injection Experiment of safely injecting carbon dioxide into South African reservoirs is essential to understanding the suitability of the local geology as a storage medium. It is also necessary to ascertain the dispersion and transformation reactions of carbon dioxide in the storage medium and its effects on the surroundings of the storage medium. This experiment will be informed by similar injection activities underway internationally.
- A demonstration plant will test an integrated operating system under local conditions and form an essential link between feasibility trials and a full-scale commercial plant. This phase will demonstrate the safe injection of carbon dioxide into South African geological formations. The magnitude of the demonstration plant is in the order of hundreds of thousands of tons of carbon dioxide per year.
- If positive outcomes of the demonstration plant ensue, a full-scale commercial plant is envisaged. This phase will be dependent on the outputs of the previous phases.

Working for Energy Programme

In 2010, the Department of Energy launched the Working for Energy Programme, with the primary objective of using the feedstock created from

clearing alien biomass vegetation to produce power.

The programme focuses on two things – the provision of energy through renewable-energy technologies and the facilitation of energy management. Both use labour-intensive methodologies to stimulate sustainable job creation, local economic development, technology skills transfer and capacity development within a South African context.

During 2011, the department spent R25 million on the Working for Energy Programme.

Through this programme, it intends to diversify its energy mix and increase access to energy. The department will ensure that all projects under this programme are labour-intensive and educational and empower communities.

National building standards

In 2010, members of the public and interested parties were invited to submit comments and input on the energy-efficiency regulations for new buildings, which were published in the *Government Gazette*.

The regulations form part of the deliverables of the National Energy Strategy that was identified in the Industrial Policy Action Plan to strengthen South African standards and regulations for energy efficiency.

The energy-efficiency regulations for residential and commercial buildings, places of learning and worship, certain medical clinics and other categories of buildings make it compulsory for all new buildings to be designed and constructed to a standard that makes it possible for the user to minimise the energy required to meet the functional requirements. Significant energy savings can be effected by users, which will relieve pressure on the electricity supply grid.

The different elements of the building envelope, namely, roofs, ceilings, walls and windows, will have to meet minimum requirements for preventing heat loss (in winter) or heat gain (in summer) to meet the energy-efficiency targets.

All buildings will also have to be fitted with renewable-energy water-heating systems such as solar systems, which also have to comply with the South African National Standards (SANS).

The regulations require that buildings, heaters, air-conditioners and mechanical ventilation systems be energy efficient.

The Department of Trade and Industry, in partnership with the South African Bureau of Stand-

ards and the National Regulator for Compulsory Specifications, was instrumental in developing regulations and supporting the SANS.

Designated National Authority (DNA)

As a signatory to the Kyoto Protocol, government has established the DNA to facilitate the development of clean development mechanism (CDM) projects. The purpose of this initiative is to ensure that the CDM investment taking place in South Africa is in line with sustainable development objectives addressing economic, environmental and social development, with the emphasis on investments, job creation, poverty alleviation, technology and skills transfer.

The projects submitted to the DNA for initial review and approval included biofuels, energy efficiency, waste management, co-generation, fuel switching and hydro-power, and sectors such as manufacturing, mining, agriculture, energy, waste management, housing, transport and residential.

These projects will help South Africa reduce GHG emissions such as carbon dioxide, which is emitted mainly by the energy sector.

A number of big industries such as Sasol, Eskom, Mittal Steel, Mondi, Sappi and South African Breweries have also taken up CDM investments with the aim of contributing to sustainable development objectives and emission reduction.

South Africa is assisting other countries in Africa to establish DNAs.

Energy statistics

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

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

The department initiated a programme to strengthen its staff's expertise and experience in collecting, verifying, analysing and publishing energy statistics. 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 National Energy Act, 2008 intends to make the provision of energy data mandatory.

Coal

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

About 77% of South Africa's primary energy needs are provided by coal. This is unlikely to change significantly in the next two decades owing to the relative lack of suitable alternatives to coal as an energy source. Many of the deposits can be exploited at extremely favourable costs and, as a result, a large coal-mining industry has developed.

In addition to the extensive use of coal in the domestic economy, about 28% of South Africa's production is exported, mainly through the Richards Bay Coal Terminal, making South Africa the fourth-largest coal exporting country in the world.

South Africa's coal is obtained from collieries that range from among the largest in the world to small-scale producers.

About 51% of South African coal mining is done underground. The coal-mining industry is highly concentrated, with five companies accounting for 85% of saleable coal production.

Production is concentrated in large mines, with 11 mines accounting for 70% 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 every year.

About 21% of the run-of-mine coal produced is exported, and 21% is used locally (excluding power-station coal). The rest is not saleable and is discarded.

The remainder of South Africa's coal production feeds the various local industries:

- 62% is used for electricity generation
- 23% for petrochemical industries (Sasol)
- 8% for general industry
- 4% for the metallurgical industry (Mittal)
- 4% is purchased by merchants and sold locally or exported.

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

By international standards, South Africa's coal deposits are relatively shallow with thick seams,

which make them easier and cheaper to mine. At the present production rate, it is estimated that there is more than 50 years of coal supply left.

Nuclear

The nuclear sector in South Africa is mainly governed by the Nuclear Energy Act, 1999 and the NNR Act, 1999. The Department of 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. Cabinet approved the Nuclear Energy Policy for South Africa in 2008.

Skills-development strategies and acquisition and retention of the relevant skills to support the nuclear programme have to be formulated. The following categories will be addressed:

- construction skills
- plant-operation skills
- skills for the relevant government departments
- regulatory skills
- supporting industry skills
- decommissioning and rehabilitation skills
- radioactive waste management.

The Nuclear Fuel Cycle Strategy for the beneficiation of uranium resources is a key factor with special focus on:

- securing South African uranium mineral resources
- developing a uranium conversion plant
- developing a uranium enrichment plant
- developing a fuel fabrication plant.

Eskom is investigating the possibility of generating up to 20 000 MW of new nuclear power capacity by 2025. This will entail recapitalising certain nuclear agencies, financing others and setting up new ones.

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

- 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, the only nuclear power station on the African continent, is responsible for about 6% of total electricity generation. It is owned by Eskom, which reports to the Minister of Public Enterprises.
- The iThemba Laboratory for Accelerator-Based Sciences brings together scientists working in the physical, medical and biological sciences. The facilities provide opportunities for modern research, advanced education, the treatment of cancers and the production of unique radioisotopes.
- The Nuclear Fuels Corporation of South Africa is responsible for uranium-ore refinement and export.

The department participates 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.

Liquid fuels

The South African liquid-fuels sector presents several opportunities for investors throughout the petroleum value chain.

In 2010, PetroSA concluded its feasibility study on a 400 000-barrels-a-day refinery at the Coega Industrial Development Zone (IDZ) in the Eastern Cape.

The proposed Mthombo oil refinery will save South Africa some R12,6 billion a year in energy costs once it is running and exporting oil across Africa. The refinery will also create employment for 27 500 people. Construction of the refinery, which will be the biggest in Africa, was expected to start in 2012, with completion by 2015.

A key feature of the South African liquid-fuels sector is that most transport fuel is produced in the coastal areas, about 68% of which is consumed in the inland Gauteng region. This requires investments in storage and distribution facilities for the supply of petroleum products at the point of need.

A new R15-billion pipeline to transport petroleum from Durban to Johannesburg is under construction.

The 555-km trunk pipeline, with pump stations, terminals and a 160-km inland pipeline network, will increase capacity from the existing 4,4 billion

South African miner Gold Fields' innovative Methane Capture Project at its Beatrix Mine in Welkom has been registered as a Clean Development Mechanism (CDM) Project with the United Nations (UN) Framework Convention on Climate Change, allowing the company to earn carbon credits.

In a bid to slow climate change, the UN gives credits to corporations and entities that initiate projects to reduce the level of pollution. Once the project has been registered as a CDM, the carbon credits can be earned and traded.

This transaction was awarded the European Energy Risk Deal of the Year Award in 2010 because it was the first Carbon Credit Project of this size undertaken by a gold mine.

The project not only reduces carbon emissions and significantly increases safety, but also generates an alternative source of clean energy, as it captures methane gas at its source, which is then piped to the surface where it is either flared or used to generate electricity. This is the first time that such a project has been implemented in South Africa.

It is expected that the carbon emissions at the operation will be reduced by 1,7 million tons between 2011 and 2018.

The revenue generated by the carbon credits has enabled Gold Fields to extract methane gas at the source, which has had a positive impact on safety as it prevents the methane from entering the mine ventilation system.

litres to 8,4 billion litres and is expected to become operational by the end of December 2013.

These mega infrastructural projects and related support infrastructure require a close and ongoing partnership between SOEs and private companies.

Sasol

Sasol is an integrated energy and chemical company. It beneficiates coal, oil and gas into liquid fuels, fuel components and chemicals with the help of its proprietary Fischer-Tropsch processes.

Sasol mines coal in South Africa, and produces gas in Mozambique and oil in Gabon. Its chemical manufacturing and marketing operations span the globe. In South Africa, Sasol refines imported crude oil and retail liquid fuels through its network of retail convenience centres. Sasol also supplies fuels to other distributors in the region and gas to industrial customers in South Africa.

Through Sasol Synfuels International, Sasol is pursuing international opportunities to commercialise its gas-to-liquid (GTL) and coal-to-liquid (CTL) technology.

Sasol has chosen a location in south-western Louisiana as the site for what could be the first plant in the United States of America (USA) to produce GTL transportation fuels and other products.

The company will embark on a feasibility study to evaluate the viability of a GTL venture in

Calcasieu Parish, and will consider two options – a two-Mt per year and a four-Mt per year facility.

The potential GTL complex will entail a capital investment of approximately US\$8 billion to \$10 billion, and could create up to 850 permanent positions and up to approximately 5 500 jobs during peak construction periods.

In December 2010, Sasol announced the world's first ethylene tetramerization unit, also to be built in Calcasieu Parish.

In September 2011, Sasol, together with partners Uzbekneftegaz and Petronas, signed an investment agreement with the Minister of Foreign Economic Relations, Investment and Trade for the Uzbekistan Government, for the development and implementation of a GTL project in that country.

Under the investment agreement, the investors and the GTL project will enjoy investment protection and fiscal benefits, to ensure the successful implementation and operation of the GTL facility.

The next phase will be the front-end engineering and design of the GTL project, which was expected to commence by the end of 2011. Depending on the final investment decision, the plant will be operational in the second half of this decade.

In 2010, Sasol approved the construction of a R1,9-billion ethylene purification unit at its Sasol polymers plant in Sasolburg.

The plant is expected to go on stream in the second half of 2013 and should be operating at full capacity by 2015, enabling the company to boost ethylene production by about 48 000 tons per year.

The ethylene will be used in the manufacture of polyethylene, and will greatly benefit South Africa's plastics conversion industry, which imports large quantities of this raw material.

Oil and gas

South Africa has very limited oil reserves and about 60% of its crude oil requirements are met

Government's infrastructure development realised important achievements with the development and approval by Cabinet in March 2011 of the Integrated Resource Plan and the Independent Systems Market Operator Bill, with the latter to stimulate greater private investment in electricity generation. Nearly 195 000 additional households were given electricity connections and five contracts were signed, adding 373 MW of capacity to the national electricity grid.

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, liquid petroleum gas (LPG) and refinery gas are produced by the following methods:

- crude oil refining (oil refineries)
- CTL and GTL fuels (Sasol)
- natural GTL (PetroSA).

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

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 rendering a reasonable return on investment to the oil industry and enhancing opportunities for employment.

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.

The department views natural gas as an evolving energy source, despite the country's limited gas reserves. There are projects underway to explore the potential of importing natural gas, both as liquid natural gas and compressed natural gas.

The Integrated Resources Plan 2010 (IRP2010) incorporates gas among alternative energy sources for electricity generation.

Cross-border gas trade agreement

To facilitate the movement of gas across international borders, cross-border gas trade agreements have been signed with Mozambique and Namibia.

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.

The South Africa-Namibia Gas Commission addresses harnessing the natural gas reserves in the Kudu Gas Field.

The first diesel exhaust fluid blend plant in Africa was opened in Centurion, Gauteng, in May 2011. The plant is the result of the Department of Energy's efforts to improve the quality of liquid transport fuels in the country.

The establishment of the plant by Blue Sky Environmental Technologies introduces AdBlue to the South African market and is a display of confidence in and support of government's efforts to improve the quality of liquid fuels as outlined in the *Discussion Document on the Review of Fuel Specifications and Standards for South Africa*.

Bluesky Environmental Technologies is a South African registered company that represents a joint venture between Kruse Gruppe Germany and Viscol South Africa.

AdBlue is used to reduce emissions of nitrogen oxide from fuels, through a process called Selective Catalytic Reduction, which is compatible with Euro four and five standards.

Euro four and five fuels contribute comparatively less to environmental pollution than earlier specifications, and are more efficient, thus leading to less carbon emissions per kilometre.

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 biofuel sector has grown rapidly internationally. However, South Africa has remained only a peripheral participant in the sector's growth. There are several reasons for this:

- being a relatively new sector, there are various complex regulatory barriers that need to be finalised
- the global economic crisis and the resultant reduction in oil prices reduced the commercial viability of some investments and negatively affected investor sentiment
- national debates have tended to focus on food-versus-fuel arguments and the potential to create biofuels using crop surpluses.

The then Department of Minerals and Energy's *National Biofuels Study* (2006) found that South Africa had significant potential to develop a commercially viable biofuels sector notwithstanding its water-poor status. The Industrial Development Corporation (IDC) and the CEF are the main investors in the sector in South Africa. The IDC in particular is involved in all four of South Africa's current biofuel projects.

The biofuels sector has strong linkages to agriculture, manufacturing and distribution and has the potential to create substantial numbers of labour-intensive jobs in the agriculture sector in particular. In addition, second-generation biofuel technology will also contribute to South Africa meeting its renewable-energy targets sustainably.

Government has committed to a 2% blend target for biofuels inclusion in the national fuel supply. In addition, several other developing countries have set blending targets of 10% for biofuels without any need for significant engine adjustment. Were South Africa to increase its blending target to 10%, some 125 000 direct jobs could be created, many of which would be based in rural areas, where the deepest pockets of poverty occur.

Electricity

South Africa is faced with a situation in which the demand for electricity continues to grow within a supply-constrained environment.

The Mass Electrification Programme, which started in the 1990s, and the ongoing rapid industrialisation of the country have put enormous strain on energy sources.

The electricity demand is expected to double over the next 20 years as government implements its Programme of Action to put the country's economy onto a higher growth path.

Reliable energy supply is also a critical factor in attracting foreign investment. Also vital and central to the country's developmental agenda is the electrification of households in rural and urban areas as part of improving the quality of life of people.

In 1994, only 51% of households had access to electricity. By 2010, this number had increased to 75%.

Integrated National Electrification Programme

The Department of Energy began funding the INEP in April 2001. Eskom implements the pro-

gramme in its licensed areas of supply on the Department of Energy's behalf. Operating costs relating to this electrification programme are incurred by Eskom as the licensed distributor supplying electricity to its consumers.

The electrification programme has a positive socio-economic impact on the lives of South Africans. There have been improvements in the education, health and social circumstances of communities that have been electrified through the grid and off-grid technologies. By 2011, South Africa's energy penetration stood at over 75%, and with R3,2 billion allocated to the INEP, the department aimed to connect an additional 150 000 households, build 10 substations and contribute about 5 000 jobs. In 2010/11, the department created 5 811 jobs and connected 195 000 homes to the electricity grid, exceeding its target by 45 000 households.

Eskom

Eskom generates, transmits and distributes electricity to industrial, mining, commercial, agricultural and residential customers and redistributors. Additional power stations and major power lines are being built to meet rising electricity demand in South Africa. Eskom will continue to focus on improving and strengthening its core business of electricity generation, transmission, trading and distribution.

Eskom buys electricity from and sells it to the countries of the Southern African Development Community (SADC). Future involvement in African markets outside South Africa (that is the SADC countries connected to the South African grid and the rest of Africa) is limited to those projects that have a direct impact on ensuring security of supply for South Africa.

Climate change

Eskom worked closely with government to ensure the success of COP17.

Clean electricity is a fundamental solution to the challenge of climate change. Eskom has been working with its partners to develop a global electricity utilities initiative that will cut across political and geographical boundaries. The initiative will highlight the significant contribution that progressive electricity utilities can make, and demonstrate how early action is already having an impact.

Eskom's response to climate change includes initiatives to reduce the carbon intensity of its existing and future plants, and making its energy mix less dependent on coal. The SADC region offers significant clean generation capacity and growth opportunities for Eskom and South Africa.

Renewable energy

Eskom has an active research programme investigating ways to harness South Africa's renewable energy sources for power generation. Eskom is looking to increase the renewables component of its supply mix.

The long-term Strategic Energy Plan includes a mix of all viable sources, including renewables, to be implemented where commercially viable. The two most advanced areas under investigation are wind-generated and concentrated solar thermal power.

Eskom's renewable energy journey has been affected by several factors, including the changing nature of power generation, environmental concerns and procuring loans that will fund solar and wind-electricity generation.

Eskom signed two loan agreements totalling US\$365 million with the African Development Bank (AFDB) in September 2011, which will go towards financing Eskom's 100-MW Sere wind farm in Vredendal, Western Cape. The loans consist of US\$265 million from the AFDB's own resources and US\$100 million from the Clean Technology Fund, a climate investment fund that promotes the transfer of low carbon technologies.

Other loans obtained to expand the programmes to develop renewable energy projects include €100 million from the *Agence Française de Développement*, and US\$260 million (part of a US\$3,75 billion loan) from the World Bank. Construction on the project began late-2011.

CSP systems use lenses or mirrors and tracking systems to focus a large area of sunlight into a small beam. The concentrated heat is then used as a heat source for a conventional power plant.

Eskom's CSP project has made significant progress since the awarding of the World Bank loan in April 2010. The required land is now owned by Eskom, water for construction and operations has been secured, and the planning around grid integration has progressed well.

Given the pace of technological developments in CSP and the time taken to finalise funding, Eskom and the World Bank decided that an inde-

pendent technology assessment was required before concluding the plant specifications. The assessment, conducted by an independent German consultancy, was completed in December 2010. The consultant confirmed Eskom's internal findings that the central receiver (CR) was the preferred technology choice and suitable for utility scale application. Eskom finalised plant specifications such as:

- a 100-MW CR demonstration plant with molten salt as a heat transfer fluid
- capacity factor greater than 60%
- two-tank storage systems with molten salt, designed for optimised, levelised energy costs
- a dry-cooled or hybrid-cooled plant – designed to optimise water usage
- all auxiliary power sourced from the national grid and backup sourced from diesel generators
- a minimum plant lifespan of 25 years.

Eskom appointed an owner's engineer in the first half of 2011 for the development and execution of the project. The plant is expected to be commissioned in the first half of 2016.

If implemented, the proposed plant will be the largest molten salt-type CR project globally, which will represent a significant step in establishing solar power as a major future energy supply option in South Africa.

To confirm government's commitment regarding the use of renewable energy, the Department of Energy has launched two flagship initiatives:

- a small-scale hydro plant in Bethlehem, Free State
- a waste-to-electricity project at eThekweni, KwaZulu-Natal.

These have added 13 MW to the total supply capacity in the country.

Compact fluorescent lamp (CFL) exchange

Through Eskom's Efficient Lighting Campaign, South Africans saved 1 800 MW between 2004 and 2010 – enough to power a city the size of Durban.

Eskom's CFL roll-out encourages South Africans to switch from incandescent bulbs to energy-efficient CFLs – miniature versions of full-sized tubular fluorescents – in line with global trends. CFLs use up to 80% less electricity than traditional incandescent light bulbs, while providing the same amount of light.

Power Conservation Programme (PCP)

The PCP aims to create a South Africa that uses electricity much more efficiently and sustainably.

The key components of the programme include energy conservation schemes to reduce energy consumption by 10% and electricity growth management to oversee new electrical connections in line with available capacity supply.

In addition, the PCP aims to provide the pricing signal to ensure the uptake of other solutions such as DSM, particularly among the top 500 consumers in the country.

New-Build Programme

Eskom's New-Build Programme was launched in 2005 with the aim of adding more than 17 000 MW to the national electricity grid by 2018. By mid-2011, more than 5 000 MW of new generation capacity and more than 3 000 km of new transmission lines had been added to the country's electricity grid.

As part of the programme, Eskom has spent R20,5 billion on recommissioning three power stations that have been out of service for over 20 years: Camden, Komati and Grootvlei, all in Mpumalanga. Together the stations can produce an estimated 3 800 MW, which equals that of a new power station. The cost of recommissioning the retired stations is estimated at almost R100 billion less than a new station, and the electricity will be available sooner. Camden was reopened in 2010, with work progressing on Komati and Grootvlei. Eskom aims to have all three operational by 2013.

Construction of two massive new coal-fired stations – Medupi and Kusile – is underway. The new Ingula pumped storage scheme will be commissioned in 2014.

The strengthening of the high-voltage power line network is gaining momentum. The acquisition of servitudes for new line routes has moved slowly and delayed the process, but these issues are being addressed.

Solar

By February 2012, government had installed 220 006 solar geysers countrywide.

Most areas in South Africa average more than 2 500 hours of sunshine per year, and average daily solar-radiation levels range between 4,5 and 6,5 kWh/m² in one day. The southern

The roughly 43,5 million compact fluorescent lamps (CFLs) introduced between 2004 and 2010 as part of Eskom's Efficient Lighting Programme holds the world record for the highest number of CFLs rolled out in one country through a single campaign.

African region, and in fact the whole of Africa, is well endowed with sunshine all year round. The annual 24-hour global solar radiation average is about 220 W/m² for South Africa, compared with about 150 W/m² for parts of the USA, and about 100 W/m² for Europe.

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 PV panel-assembly capacity totals 5 MW, and a number of companies in South Africa manufacture solar water-heaters.

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

Eskom's solar water heating programme has gained momentum, with 60 183 claims received for the solar water heating rebate, of which 41 690 were paid by the end of 2010.

Solar-passive building design

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. Government is considering the following building norms and standards: orientation for the purposes of passive solar design, lighting, and installation of solar water-heaters, insulation, ventilation, heating and air conditioning.

Solar-thermal power generation

The minimum direct normal radiation (DNR) to justify a combined solar-thermal power plant is 1 800 kWh/m² per year. According to the

Renewable-Energy Resource Database, the area exceeding the minimum required DNR in South Africa covers about 194 000 km². A 100-MW solar-thermal plant requires roughly 3 km² (1 800 kWh/m² per year).

If 1% (1 940 km²) of the identified area is available for solar-thermal power generation, South Africa has an installed potential of 64,6 GW, which is about 36 217 GWh per year. Back-up and energy-storage constraints are limiting the wider economic use of solar-electricity generation (solar thermal and PV).

Wind

Eskom's Klipheuwel wind-energy facility, 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 2002 to 2005.

During that time, the Klipheuwel Pilot Wind Farm generated more than 12 GWh of electricity, 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 the wind farm will be operated commercially for its anticipated 20-year lifespan as calculated from 2006.

The Darling Wind Farm in the Western Cape has four wind turbines, which can supply 5,2 MW. All the electricity produced will be sold to the City of Cape Town as part of a long-term power agreement with the city. The facility consists of four German-designed wind turbines. The structures are 50 m high with the blades spanning 31 m. Each turbine will produce 1,3 MW, bringing the total output of the wind farm to 5,2 MW.

The project is referred to as the National Demonstration Project and will be used as an example for future public-private partnerships in the establishment of alternative electricity generation.

The R75-million project was the first "green-energy" initiative in the country to produce electricity from wind power commercially.

It was developed through collaboration between the Darling Independent Power Producer, the Development Bank of Southern Africa and the CEF. The Danish International Development Agency also funded part of the project.

The first commercial wind farm at the Coega IDZ, Port Elizabeth, in the Eastern Cape, will have a total power capacity of 57,5 MW, which is about 10% of the Nelson Mandela Bay electricity con-

sumption, and can power about 80 000 homes with green energy.

Hydro

The Baseline Study on Hydropower in South Africa, an assessment conducted by the then Department of Minerals and Energy in 2002, indicated that specific areas in the country showed 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, that is less than 10 MW, hydropower plants.

The advantages of these plants are that they can either be stand-alone or exist in a hybrid combination with other renewable-energy sources.

Advantages can be derived from the association with other uses of water (such as water supply, irrigation and flood control), which are critical to South Africa's future economic and socio-economic development.

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 2013.

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 being harnessed is that no reliable technology for generating electricity from this resource exists.

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 is continuing resource surveys of the Agulhas Current on the east coast of South Africa and of wave energy, in partnership with the Department of Environmental Affairs and the BayWorld Centre for Research and Education.

Results have proved the technical feasibility of extracting significant large-scale renewable energy from the current.

Sustainable development on the African continent

The Intergovernmental Memorandum of Understanding (MoU) on the Western Power Corridor Project was signed in October 2004.

This New Partnership for Africa's Development flagship programme intends to pilot the use of hydroelectric energy of the Inga rapids site in the Democratic Republic of Congo (DRC). It aims to 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.

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

At the same time, the countries to the north could benefit through access to the coal-fired power resources in the south. Such an arrangement should stabilise the energy requirements of the region well into this century.

Exploitation of the vast hydropower resources will constitute a significant infusion of renewable-energy resources into the energy economy of the region over the medium to long term.

The Lesotho Highlands Water Project could 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).

Southern African Power Pool (SAPP)

The SAPP is the first formal power pool in Africa. The objectives of the SAPP are, among other things:

- coordinating and cooperating in planning and operating electricity power systems
- minimising costs, while maintaining reliability, autonomy and self-sufficiency

- increasing interconnectivity between SADC countries to increase the reliability of power supplies
- facilitating cross-border electricity trading
- fully recovering operations costs and equitably sharing benefits, including reductions in generating capacity and fuel costs, and improved use of hydroelectric energy.

Under the SAPP banner, the countries have pledged to support South Africa in areas of power generation, transmission, customer contributions and DSM.

The SAPP members include *Empresa Nacional de Electricidade* in Angola, Botswana Power Cooperation, *Société Nationale d'Électricité* in the DRC and the Electricity Supply Commission of Malawi.

Eskom is involved in the SAPP, along with other SADC country utilities, trading energy bilaterally with both utilities and industry as well as mining customers in neighbouring countries.

Energy and the global environment

South Africa is among the top 20 emitters of GHGs in the world and the largest emitter in Africa, largely because of the economy's dependence on fossil fuels. It emits more than 400 Mt of carbon dioxide per year.

The National Climate Change Strategy, developed by the then Department of Environmental Affairs and Tourism, requires that government departments collaborate in a coordinated manner to ensure that response measures to climate change are properly directed and carried out with a national focus.

The Department of Energy is expected to respond to and mitigate climate change.

South Africa is classified as a developing country or a non-Annex 1 country. This means that within the international political and negotiation context, South Africa is not required to reduce its GHG emissions. 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 emission intensity and emissions per capita.

Therefore, South Africa must proactively move the economy towards becoming less carbon-intensive, with the Department of 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.

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.

While the electricity planning process includes technologies that are currently commercially available, Eskom has modelled a number of scenarios to assess future emission profiles and the potential contribution that near-commercial lower carbon-emitting technologies can make to an emission-reduction target.

The evaluation of these options to provide the required baseload capacity includes an assessment of the risks, challenges and opportunities to fast-track these options to a point where they can be considered viable. Examples include underground coal gasification, CSP and hydro imports.

Given the country's abundance of coal reserves and the need to balance emission reductions with the affordability of electricity, Eskom is looking for increasingly efficient ways of using coal. From a coal-technology perspective, there are a number of sources that continue to predict the future performance of clean coal technologies, in terms of emissions and costs.

Significant international research and demonstration is aimed at improving the efficiency of all these technologies. The technological advances to achieve these higher efficiencies are expected to mature gradually between 2009 and 2030. The next coal-fired power station, Kusile, will be carbon-capture ready. The engineering design will cater for this requirement.

Energy and climate change

The former Department of Minerals and Energy developed the Climate Change Strategy for the energy sector in 2009. The document focuses on GHG emissions and supports the department's mitigation activities. The purpose of the strategy is to assist the department in establishing an effective response to climate change, which takes into consideration the key drivers and challenges for the sector.

The strategy ensures that the Department of Energy contributes to mitigation efforts, and positions the department to address implications of international climate-change negotiations on the country's energy industry. The strategy maximises potential benefits and minimises risks where possible, considering technological opportunities in energy efficiency, renewable energy and carbon capture and storage. Possible mitigation measures for the energy industry as a whole are addressed, not compromising economic growth and development, and other environmental objectives.

Energy and the household environment

About 950 000 households countrywide use coal. 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 standards (180 mg/m³) 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.

The Department of 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.

The White Paper on the Promotion of Renewable Energy and Clean Energy Development, 2002 commits South Africa to producing 5% of the country's energy supply from renewable energy sources by 2013.

International coordination

The Department of Energy will be engaging its counterparts in the SADC Council of Energy Ministers on the strengthening of the SAPP, and proposals for the development of an IRP for the region, taking into account that the region's countries' energy needs are interlinked and inter-

twined, and that each can contribute meaningfully to energy needs and meeting energy-efficiency challenges.

The department participates in structures such as the:

- International Renewable Energy Agency
- International Energy Forum
- International Partnership for Energy Efficiency Cooperation
- Unido
- Clean Energy Ministerial
- African Union-European Union Energy Partnership

In 2011, the department embarked on a number of international engagements in its quest to find solutions to South Africa's energy challenges. Apart from servicing its international obligations in the nuclear energy space, it has a number of other binational and multilateral agreements that it has to honour. In keeping with South Africa's membership of the Brazil-Russia-India-China-South Africa trade alliance, the country is expected to have a more pronounced role in the international arena.

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Suggested reading

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