



SA YEARBOOK 2009/10  
**ENERGY**



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

In May 2009, the Department of Minerals and Energy was divided into two separate departments, namely the Department of Mineral Resources and the Department of Energy.

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

The Electricity and Nuclear Branch is responsible for electricity and nuclear-energy affairs, while the Hydrocarbons and Energy Planning Branch is responsible for coal, gas, liquid fuels, energy efficiency, renewable energy and energy planning, including the energy database.

Government has embarked on various projects to ensure sufficient and effective energy supply during the 2010 FIFA World Cup™. It has allocated R136 million to improve electricity infrastructure around football stadiums.

## Policy and legislation

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

- attaining universal access to energy by 2014
- achieving a final energy demand reduction of 12% by 2015
- 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. Eskom will invest more than R300 billion in new-generation, transmission and distribution capacity up to 2013.

In August 2007, Cabinet approved the Energy Security 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 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 Modeling and Planning Approach, which is aimed at ensuring coordination and enhanced planning integration in dealing with future energy policy in support of achieving energy security.
- Improving Transnet Freight Rail's operational efficiencies regarding its service to the liquid-fuels sector, by focusing on routes that allow for block trains/loads and 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, which 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 Transnet Pipelines' new Multi-Products Pipeline, which is necessary to alleviate the identified capacity constraints in the petroleum supply chain.

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Project Mthombo is a modern world-class refinery that aims to provide the lowest-cost refined products sufficient to cater for the country's needs until 2030. Mthombo is expected to enable the economic introduction of globally competitive clean fuels, ensuring that South Africa meets new, best-practice standards that improve the environment and contribute towards maintaining the competitiveness of the vehicle-manufacturing industry.

The project is expected to have a positive impact on government's stated objectives of skills training and transfer, creating thousands of jobs associated with supporting and operating this mega refinery. The project aims to further:

- attract foreign direct investment
- generate a significant and sustainable improvement in the Eastern Cape's economy
- provide considerable prospects for Broad-Based Black Economic Empowerment and small, medium and micro-enterprise participation.

The South African National Energy Development Institute was established in 2009 to conduct energy research and development as well as implement energy-efficiency and renewable-energy programmes on behalf of government.



- 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.

In 2008, the National Energy Act, 2008 (Act 34 of 2008), which covers sustainable energy development and gives certain powers to the Minister of Energy, was promulgated.

It provides for possible interventions to ensure energy security and uninterrupted availability of energy supplies, makes regulations pertaining to appliances, addresses environmental requirements on the subject of climate change and water use, enforces mandatory cooperation in the development of sector energy plans and establishes the National Energy Efficiency Agency.

The National Radioactive Waste Disposal Institute Act, 2008 (Act 53 of 2008), was promulgated in January 2009 to provide for the establishment of the institute to manage radioactive waste disposal on a national basis.

## Energy and the economy

Energy creates jobs for about 250 000 people. Eskom's electricity sales totalled 224 366 gigawatt/hour (GWh) in 2008.

It generates around 95% of the electricity used in South Africa and exports to countries in Africa.

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 about 88% coal, is especially challenging.

South Africa has an abundance of low-cost coal, which means that reliable and inexpensive supplies are at hand.

## National Energy Regulator of South Africa (Nersa)

Nersa, which was launched in November 2005,

is the regulatory authority established in terms of the National Energy Regulator (NER) Act, 2004, (Act 40 of 2004), with the mandate to undertake the functions of the gas regulator as set out in the Gas Act, 2001, (Act 48 of 2001); the Petroleum Pipelines Regulatory Authority, as set out in the Petroleum Pipelines Act, 2003 (Act 60 of 2003); the NER as set out in the Electricity Act, 1987 (Act 41 of 1987), as amended; and the Electricity Regulation Act, 2006 (Act 8 of 2006), as amended.

By June 2009, Nersa had promulgated renewable energy feed-in tariffs for a number of clean-energy technologies. This is an opportunity not only to meet the Department of Energy's policy objectives in the clean-energy space, such as 10 000 GWh by 2013, but also to open opportunities for rural and local economic development, where the biggest need for employment and infrastructure development is located.

The feed-in tariffs will enable greater use of solar water-heating, wind energy and mini hydro schemes. The Department of Energy aims to ensure that one million solar water-heaters are installed in households and commercial buildings from 2010 to 2014. This programme has the potential to create up to 100 000 jobs across the value chain that will include manufacturing, installation and maintenance.

## Central Energy Fund (CEF)

The CEF is involved in the search for appropriate energy solutions to meet the future energy needs of South Africa, the Southern African Development Community (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 producing 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 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 liquified petroleum gas (LPG) in South Africa.

## Energy efficiency

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

This strategy allows for the immediate implementation of low-cost and no-cost interventions, as well as those higher-cost measures with short pay-back periods.

These will be followed by medium-term and longer-term investment opportunities in energy efficiency.

The strategy acknowledges that there is significant potential for energy-efficiency improvements across all sectors of the national economy.

The vision of the strategy is to contribute towards affordable energy for all, and to minimise the negative effects of energy use on human health and the environment. This will be achieved by encouraging sustainable energy development and energy use through efficient practices.

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 Energy and Eskom, by signing an energy-efficiency accord, thus committing themselves to targets in the department's strategy.

According to the first review of the National Energy-Efficiency Strategy of 2008, 14 of these

Eskom, together with Sasol, PetroSA, Anglo American and the South African National Energy Research Institute, is sponsoring the development of the South African Carbon Dioxide ( $\text{CO}_2$ ) Storage Atlas. The atlas will represent an early assessment, aimed at identifying areas and estimating the potential capacity for geological storage of  $\text{CO}_2$  in South Africa.

In July 2009, government launched a game aimed at teaching children how and why to save energy. The game, distributed for free via the Internet and MXit, was officially launched by the Minister of Energy, Ms Dipuo Peters, at Tigerkloof Combined School in Vryburg in the North West.

The digital game, called *Save It*, featured three superhero characters trying to thwart the Energy Guzzler, a power-wasting monster, who was using up all the electricity. The characters had to outmanoeuvre the Guzzler, beating him by saving as much power as they could before he could undo their good work.

The game was aimed at primary-school children who were able to compare their scored points with other MXit users across the country.

The game was developed by government as part of its National Energy-Efficiency Campaign, comprising a schools roadshow and a communication campaign aimed at educating South Africans about the importance of saving energy.

consumers invested R9,9 billion on energy-efficiency improvements and saved 1 441 GWh and 5 190 terajoules of energy over the three-year period. This is equal to the entire residential sector consumption for two days.

The constraints on Eskom's energy supply will continue until additional supply-side initiatives become operational in 2012. A certain amount of energy needs to be removed from the system to manage this constraint. This can be achieved by cogeneration, demand side management (DSM) and a substantial shift in energy-saving behaviour.

Eskom's DSM is working to effect a reduction of 3 000 megawatt (MW) by March 2011 and a further 5 000 MW by March 2026. This involves the installation of energy-efficient technologies to alter Eskom's load and demand profile.

These technical solutions are seen as "hard-wiring" energy-efficiency measures that ensure a higher level of security of supply in the short to medium term.

The Department of Energy's energy-efficiency and DSM policies guide the implementation of DSM, with energy and demand savings being verified by independent university measurement and verification professionals.

The programme within the residential, commercial and industrial sectors has seen an exponential growth in DSM savings, with the programme exceeding its annual targets. The 2009 saving was 916 MW, against the target of 645 MW. This increased the cumulative



saving to 1 999 MW since the inception of DSM in 2003.

Initially, Eskom's DSM focused on realising energy and average demand savings during evening weekday peak periods (18:00 to 20:00) via energy-service company projects in the industrial and commercial sectors and hot water-load management within municipal environments.

With the need to reduce demand, the focus expanded to include mass energy-efficient programme roll-outs that could be rapidly implemented.

These included energy-efficient lighting utilising compact fluorescent lamps (CFLs), solar water-heaters and improving the efficiency of electric motors and pumps.

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 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 assists with promotional activities regarding the national energy-efficiency drive.

Its initial focus is on prioritising and recommending energy efficiency and DSM projects.

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

The NEEA oversees the integration and coordination of training in existing energy-efficiency projects, and assists with skills transfer, capacity-building and the creation of additional jobs in the field of energy conservation.

In August 2009, President Jacob Zuma signed an oil agreement with Angolan President, Mr Jose Eduardo dos Santos, during a visit aimed at strengthening economic ties with the oil-rich country.

The deal will allow South Africa's PetroSA and Angola's Sonangol to cooperate in oil projects and work together in the areas of exploration, refining and distribution of oil.

President Zuma was accompanied by 11 ministers and more than 100 business leaders – the largest business delegation to accompany a state visit since the end of apartheid in 1994.

In line with the National Energy-Efficiency Strategy, the NEEA is subject to review every three years.

Saneri facilitates skills development and undertakes research and technology development that will ensure that South Africa's energy resources are used and optimised.

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

Saneri is hosting the Green Transport Programme, which aims to showcase green transport technology options during the 2010 World Cup and beyond.

### **Integrated energy planning (IEP)**

Energy efficiency is an important facet of the IEP process carried out by the Department of Energy.

By virtue of its size and economic importance, the energy sector periodically requires considerable investments in new supply capacity, which imparts on the economy. Integrated resource-planning decisions around the world consider not only maintaining security of supply, but give consideration to the economic, environmental and social impacts of all alternatives, such as DSM and energy-efficiency programmes.

This Energy-Efficiency Strategy will be used to inform the National Integrated Resource Plan of the NER as well as the National Integrated Energy Plan of the Department of Energy.

### **Efficient lighting roll-out programme**

It has been established that of the more than 10 million electrified households in South Africa, there is an estimate of eight incandescent lights per household.

During the Eskom CFL roll-out in 2008, a saving of 800 MW was achieved by replacing incandescent lamps with CFLs.

The final target is to reduce the demand by 26 terawatthours by 2012. The programme also accommodates a free CFL exchange for low-income households until 2015. To ensure that this roll-out is sustained, the Department of Energy, in collaboration with other government departments, intends to issue a restriction on the manufacturing of incandescent light bulbs.

The National Treasury also indicated that there would be a tax raised on incandescent bulbs. There will be certain exclusions granted for lamps for ovens, microwaves and for sensitive buildings and special cases.

By September 2009, more than 30 million lamps had been replaced.

## Solar water-heating programme

The Department of Energy and the CEF have embarked on a solar water-heating project, which promotes the use of solar geysers.

The programme targets households, group houses (such as military bases and mine residences) and commercial and industrial applications.

Government has set a target of one million solar water geysers to be installed in households and commercial buildings in the next five years.

Eskom's Solar Water-Heating Programme is an initiative that could lead to a reduction in demand of about 530 MW on the national grid and a favourable contribution to reducing carbon emissions.

At the core of the strategy is a subsidy offered to home owners, aimed to stimulate the uptake of solar water heaters. It is believed that the high capital costs are limiting the rate of market acceptance of such systems.

The Solar Water-Heating Programme offers an incentive to consumers to replace existing electrical heating geysers with solar-heating geysers. The strategy is to create a sustainable solar water-heating industry in South Africa and achieve a 166 MW demand reduction in three years. For the 2009 financial year, over 700 units were installed.

Since the launch of the Eskom Solar Water-Heating Programme, certain processes have been modified as a better understanding of the solar environment's requirements developed.

Eskom is striving to streamline solar heating-related industries to comply with the South African Bureau of Standards (SABS) and other applicable regulatory and legislative requirements. Eskom hopes that, through increased demand and manufacturing capacity, more competitive prices will materialise.

## Hospitality industry

The Department of Trade and Industry intends to proclaim that the hospitality industry converts all water heating to solar power. The water-heating method can be in the form of solar pre-heaters, thereby ensuring that electricity is not used whenever there is enough solar radiation available to heat water.

## National building standards

Local governments have indicated that municipal bylaws will entrench energy-efficient behaviour. This can be done by ensuring that the building standards to improve energy efficiency are legislated and implemented.

In April 2009, Eskom announced that it was planning to spend about R385 billion between 2010 and 2014 on its capital expansion programme.

The SANS 204 standard for buildings was approved in 2008 and will become part of the National Building Regulations of the Department of Trade and Industry. This standard provides for a minimum required energy-efficiency performance per square meter of any building.

## Labelling of vehicles

The SABS standard for the labelling of all new light motor vehicles became compulsory in July 2008. This label gives an indication of the carbon emissions of the vehicle as well as its fuel consumption to ensure buyers make an informed decision with regard to the energy efficiency of the vehicle.

## Smart metering for residential customers (load management)

Although smart metering can be initiated in the short term, the benefits will be reaped in the medium to long term. Smart metering requires the use of wireless technologies, which have to be retrofitted to existing conventional and pre-paid meters. In this manner, the utility (Eskom or the municipal electricity distributor) will be able to remotely manage customer load.

A quick cost-benefit analysis indicates that improved communication between the utility and the customer meter will result in considerable energy savings during peak demand periods.

The potential reduction is estimated to be 3 265 MW, made up of:

- geysers: 2 161 MW
- laundry (2% contribution to peak): 246 MW
- pool pumps (1% contribution to peak): 122 MW
- other appliances (6% contribution to peak): 736 MW.

## Fuel switching

This refers to a Department of Energy-driven LPG Pilot Project, which aims to:

- convert and connect households to LPG
- promote LPG as an appropriate household energy for thermal purposes with a long-term view of converting consumers to natural gas as and when it becomes available throughout the country
- contribute towards the DSM interventions of energy, especially with regard to electricity use during peak periods

- inform the department on the important policy issues and insights into the operation of the LPG industry, which will be used to inform policy.

Some challenges have to be overcome in respect of fuel switching to LPGs. Firstly, the affordability of LPG appliances for low-income households proves to be a barrier to the use of LPG, hence the subsidisation undertaken by the department of such appliances. Secondly, sustainable supply of the product will have to be resolved in the long term.

This would require investment in logistical infrastructure and import terminals associated with trading in LPG, as well as increased local production during seasons when large volumes of LPG are consumed.

## **Designated National Authority (DNA)**

The then Department of Minerals and Energy established the DNA to review 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.

During 2008/09, the department approved 45 projects, which brought the total number of projects approved by the DNA since its inception to 107.

About 15 of these projects were registered by the CDM Executive Board and four projects were issued with certified emission reductions.

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.

By September 2009, the Engcobo, Inxuba Yethemba and Umhlonhlo rural electrification projects, which would see an investment of R170 million in the infrastructure development of Chris Hani and Alfred Nzo district municipalities, were launched.

Government aims to support this initiative through the provision of energy infrastructure. The Department of Energy's contribution to the pilot project in Giyani was expected to total R10 million for rural electrification.



These projects have the potential of contributing to government's sustainable-development objectives in the form of poverty alleviation and job creation, access to clean energy by contributing to renewable energy and energy-efficient targets, technology transfer and economic development. These projects will assist South Africa to reduce greenhouse-gas (GHG) emissions such as carbon dioxide, which is emitted largely by the energy sector. Collectively, these projects' lifespan will reduce about 42,3 million ton (Mt) of carbon dioxide equivalent per year, bring foreign revenue of about R423 million (at 10 Euros per ton) and contribute about 52 121 MW by way of electricity generation and energy savings.

These projects are located in provinces such as KwaZulu-Natal, Gauteng and the Western Cape. The majority of these projects are implemented at local government level, notably within the metropolitan municipalities. The potential revenue that will be generated through the sale of certified emission reductions will bring additional revenue streams to municipalities to improve their service delivery.

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 decisions.

The Department of 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 National Energy Act, 2008, intends to make the provision of energy data mandatory.

## **Integrated Energy Centre (IEC) 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 mid-2009, there were six 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; Mutale IEC, Limpopo; and Ratlou IEC in Makgobstad, North West. 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.

## **Energy demand and access**

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 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 the commercial, industrial and household sectors.

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

The estimate number of households with access to electricity increased from 4,5 million (50,9%) in 1994 to 9,1 million (73%) in 2008.

Close to half of all customers who receive electricity services from municipalities receive free

The Minister of Energy, Ms Dipuo Peters, announced in November 2009 that the Department of Energy would submit a proposal to Cabinet to start building the first of South Africa's new fleet of nuclear power plants by 2020. This will enable the local industry to develop new technologies and skills, and create up to 70 000 direct and 300 000 indirect jobs.



basic electricity, with a large percentage of such users in Gauteng and Free State. Better long-term planning in terms of generation, distribution and maintenance is critical for the achievement of the goal of universal access to electricity by 2014.

## **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.

Burning coal is the most cost-effective and energy-efficient way of generating electricity. Internationally, coal is the most widely used primary fuel, accounting for about 36% of the world's electricity production.

Coal has traditionally dominated the energy-supply sector in South Africa, from as early as 1880 when coal from the Vereeniging area was supplied to the Kimberly diamond fields.

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

South Africa produces an average of 224 Mt of marketable coal annually, making it the fifth-largest coal-producing country in the world.

About 25% of the production is exported internationally, making South Africa the third-largest coal-exporting country. The remainder of South Africa's coal production feeds the various local industries, with 53% used for electricity generation. The key role played by coal reserves in the economy is illustrated by the fact that Eskom is the seventh-largest electricity generator in the world, and Sasol the largest coal-to-chemicals producer.

## **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 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 June 2008.

The objective of the policy is to increase the role of nuclear energy as part of the process of diversifying South Africa's primary energy sources

The African Nuclear-Weapon-Free Zone Treaty came into force in August 2009, about 13 years after it opened for signature.

The treaty, which covers the entire African continent as well as its surrounding islands, ensures that nuclear weapons are not developed, produced, tested or otherwise acquired or stationed in any of the countries on the continent.

For the treaty to come into effect, a total of 28 or more countries – of the 53 who have signed the document – had to ratify it. Burundi was the 28th to do so in July 2009.

Among other things, the treaty supports the use of nuclear science and technology for peaceful purposes, and requires each party to conduct all activities for the peaceful use of nuclear energy under strict non-proliferation measures.

It will also prevent any foreign naval ship or vessel carrying nuclear weapons from entering an African port without prior permission.

to ensure energy security. The policy will also ensure the reduction of the overreliance on coal, which contributes to South Africa being among the highest emitters of GHGs.

Eskom is investigating up to 20 000 MW of new nuclear power capacity by 2025. This would 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 Energy plays a leading governance role regarding nuclear technology, non-proliferation and safety. The Minister of Energy is the executive authority responsible for overseeing the South African Nuclear Energy Corporation (Necsa) and the NNR.
- Necsa undertakes and promotes research and development (R&D) in the fields of nuclear energy, radiation science and technology (S&T), 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 hazard-

ous 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% 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.

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.

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.

The Department of Energy continues to work on finding safer ways to use nuclear power and store nuclear waste.

The department continued with the implementation of the Waste Management Policy and Strategy and aimed to establish the National Radioactive Waste Disposal Institute during the 2009/10 period, to manage and regulate radioactive waste material in accordance with international standards to ensure the protection of people, property and the environment.

The department aims to implement the Nuclear Energy Policy, which seeks to firmly place nuclear energy as one of the solutions to mitigate against GHGs.

### Nuclear Energy Corporation of South African

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

The main functions of Necsa are to undertake and promote R&D in the field of nuclear energy and radiation S&T; to process source material, special nuclear material and restricted material; and to cooperate with persons in matters falling within these functions.

Apart from its main operations at Pelindaba, which include the Safari-1 research reactor, Necsa also operates the Vaalputs National Radioactive Waste Disposal Facility, which is licensed to receive low and intermediate radioactive waste.

In line with the non-proliferation initiatives, Necsa aims to convert the Safari reactor from using highly enriched uranium to low enriched uranium.

South Africa has technical expertise in nuclear technology at Necsa, including expertise in uranium conversion and enrichment remaining from South Africa's previous nuclear programme.

The Nuclear Energy Policy and Strategy for South Africa states that government, through Eskom, is taking the lead in respect of the extensive Pressurised Water Reactor to substantially diversify the generation base and reduce overall carbon emissions.

The policy also highlights that in this extended programme, Necsa will play a vital role as the State's body to serve as the anchor for nuclear energy R&D and innovation in South Africa.

To implement a sustainable nuclear programme and obtain all the potential economic benefits, South Africa, through Necsa, will endeavour to implement, or obtain interests in, the complete nuclear fuel cycle, including uranium conversion, enrichment and fuel fabrication. Necsa hosts the Pebble-Bed Modular Reactor nuclear fuel development laboratories, helium tests facility and the future Fuel Production Plant.

Through its fully owned commercial subsidiaries Pelchem (Pty) Limited (Ltd) and NTP Radioisotopes (Pty) Ltd, it sells fluorine and fluorine-based products as well as radioisotopes on the international market.

The NTP Radioisotopes (Pty) Ltd is among the top three global producers and suppliers of

radiation-based products and services that are routinely and reliably provided to customers throughout the world.

Its principal product, Fission Mo-99, is used in products that allow for the estimated 30 million nuclear medicine imaging scans performed on patients throughout the world every year.

The NTP supplies more than 90% of the total South African nuclear medicine demand through its subsidiary companies AEC Amersham (Pty) Ltd and Cyclotope (Pty) Ltd.

The latter pioneered the introduction to South Africa of the first commercially available positron emission tomography tracer. In addition, NTP supplies radioisotopes used for industrial applications to the entire South African market and exports these products to a number of countries through its distributors.

The NTP Logistics (Pty) Ltd specialises in the international and domestic transport of radioactive and other dangerous goods.

### 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 historically disadvantaged South Africans
- creating employment opportunities and small businesses in the petroleum sector.

The Liquid Fuels Charter compels industry participants to provide for 25% black empowerment in all sectors of its operations, including its value chain and shareholding.

The South African Petroleum Industry Association (SAPIA) expected demand to be close to unchanged in 2009 from 2008 and receive a slight boost from projects related to the Soccer World Cup in 2010.

Demand for petrol dropped more than 10% in the third quarter of 2008 compared with the same period in 2007, while demand for diesel was down more than 3%, as big industrial consumers scaled down operations because of the global economic slowdown.

The drop served as a buffer for South Africa, which has battled a capacity shortage in recent years, especially when refineries were forced to shut down unexpectedly.

According to SAPIA figures, sales of major petroleum products in South Africa amounted to 18,9 billion litres in the first nine months of 2008.

Relief will come if the 400 000 barrels-per-day (bpd) Coega oil refinery built by state-owned PetroSA comes on stream in 2015.

It will nearly double the existing refining capacity, which is estimated at around 460 000 bpd.

A feasibility study for the refinery at Coega, an industrial development zone on South Africa's south-east coast, was due to be completed by August 2009.

Backed by government, the Coega refinery will also ease the country's dependence on fuel imports. The refinery itself would need some 200 MW to operate, but the rest could be used to supply local industry and communities.

The refinery is expected to create about 18 500 permanent jobs in the Eastern Cape.

The refinery is expected to save South Africa around R18,5 billion a year in imports. Half of the refinery's output is also expected to supply sub-Saharan Africa.

PetroSA was also studying, along with Transnet, the possibility of building an alternative fuel pipeline for South Africa, to ease congestion on the Durban-Johannesburg line.

The petrol price in South Africa is linked to the price of petrol in United States dollars 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.

PetroSA is responsible for exploring and exploiting oil and natural gas, as well as producing and marketing synthetic fuels produced from

The Safe Illuminating Paraffin Stove Pilot Project was launched by the Minister of Energy, Ms Dipuo Peters, at Port Shepstone, KwaZulu-Natal, in October 2009.

The project aims to promote the use of safer illuminating paraffin appliances while addressing problems associated with harmful incidents caused by the use of illuminating paraffin in low-income households in South Africa.

It also aims to test the robustness and safety of the newly designed, table-height paraffin stoves to minimise incidents associated with safe handling and usage of the paraffin, fuel and related appliances. The Government committed itself to promoting energy access and managing energy-related environmental and health impacts, as stated in the *Energy White Paper* of 1998.



offshore gas at the world's largest commercial gas-to-liquids (GTL) plant in Mossel Bay.

The former Department of Minerals and Energy, together with the oil industry, established the Fuel Strategic Supply Task Team to identify 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.

### 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.

It 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 GTL and coal-to-liquids (CTL) technology. In partnership with Qatar Petroleum, Sasol started up its first international GTL venture, Oryx GTL, in Qatar in 2007 and is developing a GTL plant in Nigeria with Chevron and the Nigerian National Petroleum Corporation.

Based in South Africa, Sasol has operations in about 30 countries and employs almost 34 000 people.

Formed in 1950, the company started producing synthetic fuels in 1955. Sasol is listed on the Johannesburg Securities Exchange in South Africa and the New York Stock Exchange in the United States of America (USA).

### Oil and gas

South Africa has very limited oil reserves and about 60% 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)
- CTL and GTL 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 rendering 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 Mossgas 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.

### 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 rose 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.

In June 2009, Sasol, South Africa's multinational fuel and chemicals company, opened a R70-million Fuels Application Centre in Cape Town, in the company's biggest intervention to test the impact of its fuels on vehicle performance and greenhouse-gas emissions.

The centre is one of a handful of such test facilities in the world, and the first of its kind in southern Africa. It is an extension of the existing fuels research facility situated at the Sasol Research and Development facility in Sasolburg, in the Free State, and adds to the work done at the Sasol Advanced Fuels Laboratory at the University of Cape Town.

Established in 1950 as a state-owned enterprise, Sasol invented the technology for making petrol and diesel from coal. Its main plant in Mpumalanga – the only commercial coal-to-liquid plant in the world – produces about 150 000 barrels of synthetic fuel a day and meets about 28% of South Africa's annual fuel needs.

The new Cape Town facility will use some of the most advanced engine-testing and emission-measurement technologies, helping Africa compete with the world's best fuel-research facilities.

### 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 Industrial Strategy for South Africa was approved by Cabinet in December 2007. Within the first five years, which is considered to be a pilot phase, the aim is to achieve a 2% penetration level of biofuels, or 400 million litres (Ml) a year.

In line with the focus on rural development and the provision of support to emerging farmers, the Government proposed that only dual-purpose crops should be used for the production of biofuels. Examples are sugar cane and sugar beet for

bioethanol production and sunflower, canola and soya for biodiesel.

Maize was taken out just before the final strategy was approved because of food-security concerns.

Jatropha, which is not a dual-purpose crop, was excluded to allow further research into its properties.

A 19-MI ethanol project is being developed by the CEF, the Industrial Development Corporation and the Eastern Cape Government, giving effect to the Government's biofuels strategy. The project has been under development since 2007 and is expected to be commissioned in December 2011.

The project has the potential to create a viable fuel-grade ethanol business based on sugar beet grown in the Eastern Cape's Great Fish River Valley. The agricultural activities will create 1 500 jobs over and above 1 000 temporary jobs that will be created during the construction of the ethanol processing plant.

This is one of many projects that will be developed over the next five years. Government's goal is to displace at least 5% of crude oil-based fuels with biofuels.

## Electricity

Eskom generates about 95% of electricity in South Africa and about 45% in Africa. About 88% of South Africa's electricity is generated by coal-fired power stations. Koeberg, a large nuclear station near Cape Town, provides about 6% 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 also owns and operates the national electricity grid.

In global terms, the utility is among the top 13 in generating capacity, among the top nine 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 Energy has several policies 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. In 2008, the problem was exacerbated by low coal reserves at the Eskom power stations, as well as quality-related issues.

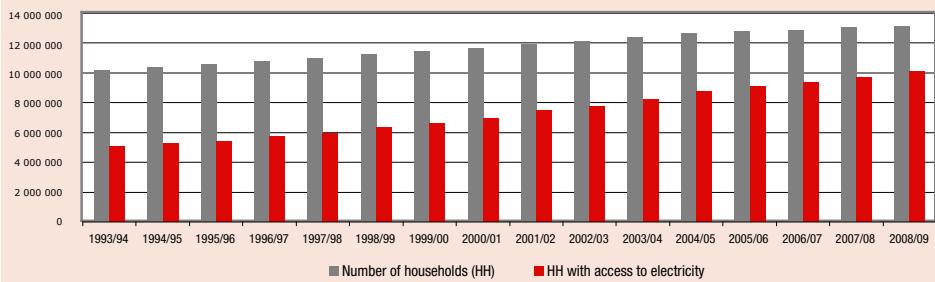
The status of the electricity system has changed dramatically. A decrease in demand, together with the technical recovery of Eskom power, brought about a much healthier reserve margin, moving from around 5% in January 2008 to about 14% in January 2009 (including imports). The coal stockpiles have also been restored to much healthier levels.

The Eskom Build Programme is on track to deliver the projects as planned. Since the Build Programme started in 2005, additional capacity of 4 454 MW was commissioned up to 30 April 2009.

Over the five years to March 2013, Eskom aims to spend R385 billion in nominal terms on capacity expansion. South Africa plans to build 40 000 MW of new-generation capacity by 2025, of which 12 476 MW are already under construction.

As at 30 April 2009, 4 454 MW of this had already been commissioned. A further 6 134 MW would come on stream within the following five years (which included the 2009 calendar year). This includes the completion of the two remaining old coal-fired stations being returned to service,

Households with access to electricity



Source: *Development Indicators, 2009*

the upgrade of Arnot Power Station and the first three units of Medupi and the first unit of Kusile.

Some highlights for 2008/09 were as follows:

- Camden Power Station fully operational (eight units)
- two units of Grootvlei Power Station synchronised to the grid
- one unit of Komati Power Station synchronised to the grid
- two more open-cycle gas turbine units at Gourikwa Power Station commissioned.

Some 1 962 km of high-voltage transmission lines have been built in the past few years, as well as numerous new transmission substations and transmission network upgrade projects. The construction of the 765-kilovolt ultra high-voltage line to the Western Cape is progressing well, with 430 km already strung. The Apollo Substation refurbishment was completed in May 2008. This increases the availability of the Cahora Bassa/Apollo high-voltage direct current interconnection.

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 beneficators and other large industries. In addition, it supplies directly to commercial farmers and, through the Integrated National Electrification Programme (INEP), to a large number of residential consumers. It sells in bulk to municipalities, which distribute to consumers within their boundaries.

### **Integrated National Electrification Programme**

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

Since its inception in 2002, the INEP has provided 4,8 million households with access to electricity. By March 2009, government had spent R8 billion on electrification.

However, the rate of new connections was slowing down because bulk infrastructure needed to be provided in the backlog areas not previously served.

If universal access to electricity is to be achieved by 2014, improved planning, resource optimisation and complementary approaches to distribution and maintenance are vital.

In 2008, government committed to supporting more efficient use of energy by installing electricity-saving devices, using renewable sources of

electricity generation and exploring co-generation projects. Government aims to spend R1,5 billion on those projects over the spending period.

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 kWh of free electricity per month. Eskom and municipalities are the service-providers for free basic electricity in their respective areas of supply.

Between April 2007 and March 2008, access to free basic electricity increased from 60% to 73%.

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 kilowatt-hour (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 Cooperative Governance and Traditional Affairs 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 Energy removed the value-added tax levy on it.

### **Renewable energy**

The Department of Energy has embarked on a number of renewable-energy projects geared at increasing power generation in the country. Renewable-energy sources, other than biomass,

By June 2009, private investors had injected R1,8 billion into building a new sugar-processing facility in the rural area of Makhathini, in the far north of KwaZulu-Natal.

The project, which is a joint initiative between the Department of Trade and Industry, local municipalities and sugar growers, aims to produce ethanol and other sugar by-products from raw sugar cane.

Ethyl alcohol, or ethanol, is an alternative fuel that can be blended with petrol to produce fuel with a higher octane rating and lower harmful emissions. It is produced by fermenting materials that contain starch or sugar.



have not yet been exploited optimally in South Africa.

The Department of Energy strengthened international relationships in this area through the support offered to partnerships established during the World Summit on Sustainable Development 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: a 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 (such as CDM and "green" premium)
- 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 availability of natural resources.

These technologies include:

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

The department has subsidised six renewable-energy projects (three hydro projects, one wind project, one landfill gas project and one biogas-to-electricity project) with a total capacity of 24 MW. The department spent R15 million on these projects. Nersa approved and published renewable-energy feed-in tariffs in 2009. Four technologies, namely wind, landfill, small-scale hydro and concentrated solar power were included in the feed-in tariff framework. Other technologies will be considered by the regulator in future.

Eskom participated in a pilot project of the Department of 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.

Its Renewable Energy Strategy states a commitment to increase the share of renewable energy in Eskom's energy mix.

In March 2009, the department hosted the Renewable Energy Summit to review the Renewable Energy White Paper Policy.

The summit noted that insignificant progress had been made towards the achievement of the target.

The Department of Energy, together with stakeholders, adopted a new set of resolutions to accelerate the implementation of the renewable-energy programme and are continuing with the process of policy review, taking into consideration the outcomes of the summit.

## Biomass

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

The Department of Energy has identified biomass as one of the easiest and quickest sources of renewable energy that can contribute towards its targets. Through negotiations and agreements

with the former Department of Environmental Affairs and Tourism, most landfill sites would not require a full environmental impact assessment, which reduces costs and time spent on developing these projects.

The department is also providing a capital subsidy for these projects. The Energy Development Corporation at the CEF has established partnerships with a few municipalities to utilise landfill sites to generate electricity.

In April 2009, the department launched the Working for Energy Programme, which focuses on using wood harvested through the Working for Water Programme to generate electricity from mainly biomass sources.

Biomass pulp and paper have the potential to generate about 110 GWh; landfill gas about 597 GWh; and 57 municipalities own landfill sites that have the potential to generate about 1 200 GWh per annum.

One of South Africa's best bets is electricity generation from bagasse, with a potential of about 5 846 GWh. The South African Sugar Association suggested that it could contribute at least 400 MW (equivalent to 2 000 GWh) through co-generation by 2013.

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.

### **Renewable-energy subsidy office**

In 2005, the department established the Renewable-Energy Finance and Subsidy Office, with a mandate that includes the management of renewable-energy subsidies and offering advice to developers and other stakeholders on renewable-energy finance and subsidies.

Since 2006, financial aid to the value of about R15 million has been successfully provided, investments of more than R300 million from the private sector had been leveraged and more than 160 jobs, even though some temporary, were created.

An additional capacity of 24 MW was added to the electricity network.

### **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.

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.

Solar water-heating is used to a certain extent. 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 cooperatives 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.

Concentrating solar power (CSP) technologies use large, sun-tracking mirrors to concentrate solar radiation and generate steam for power generation.

Pilot, and more recently, commercial CSP power stations have provided the cheapest electricity to be generated using solar power. Eskom's CSP Project forms part of the South African Bulk Renewable Energy-Generation Programme.

The research will establish the feasibility of using CSP as a large-scale generation option for Eskom.

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

In October 2009, the Clinton Climate Initiative partnered with government to assess the possibility of building its first solar park, which could add up to 5 000 MW of electricity to South Africa's energy.

The Minister of Energy, Ms Dipuo Peters, signed a memorandum of understanding (MoU) to assess the potential of building the infrastructure.

A solar park would serve as a concentrated zone of solar development and would include

significant solar-generation capacity by different independent power producers.

### 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/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, 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 economical use of solar-electricity generation (solar thermal and PV).

### 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 2002 to 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 the wind farm will be operated commercially for its anticipated 20-year lifespan as calculated from 2006.

The R75-million national demonstration project in Darling in the Western Cape was the first

"green-energy" initiative in the country to produce electricity from wind power on a commercial basis.

The Darling Wind Farm has four wind turbines, which can supply 5,2 MW. All the electricity produced would 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 would be used as an example for future public-private partnerships in the establishment of alternative electricity generation.

The project 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.

### Hydro

The Baseline Study on Hydropower in South Africa, an assessment conducted by the former Department of Minerals and Energy, 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, 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.

Advantage can be derived from the association with other uses of water (such as water supply, irrigation and flood control), 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 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 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 continues with 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 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 DRC. It aims to ensure the security of supply in the Southern African Development Community (SADC).

The participating utilities are those of Namibia, South Africa, the DRC, Botswana and Angola.

A joint-venture company has been formed to initiate studies determining the viability of the project and to build, own and operate the infrastructure.

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 would 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

The SAPP is the first formal power pool in Africa.

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

- coordinate and cooperate in planning and operating electricity power systems to minimise costs, while maintaining reliability, autonomy and self-sufficiency
- increase interconnectivity between the 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.

The SADC has joined hands to ensure that South Africa has enough electricity during the 2010 Soccer World Cup.

A Danish-South African joint venture is set to produce a new wind atlas of the country, determining the wind resources available for wind-energy generation.

Government aims to produce 10 000 Gigawatt/hour of electricity from renewable sources by 2013 – wind energy included.

About 20% of Denmark's electricity demand is generated by wind, and the country is eager to expand its energy-export sector to Africa.

An annual average wind speed of six meter per second (m/s) to 7 m/s is required to make wind-energy generation at wind farms possible.

According to the Department of Energy's South Africa Wind Energy Programme (Sawep), the country's existing atlases cannot assist industry in compiling bankable wind-energy projects for the country.

Sawep aims to increase South Africa's use of wind energy and is contributing R5 million to the Wind Atlas Project, with the Danish Embassy providing R20 million.

The project will specifically target the Western Cape, as well as areas of the Northern and Eastern Cape. The first version of the atlas is expected to be available in 2010.



Under the SAPP banner, the countries have pledged to support South Africa in areas of power generation, transmission, customer contributions and DSM. This initiative was part of Eskom's plans to ensure the reliability of electricity supply for the 2009 Confederations Cup and the 2010 FIFA World Cup™.

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

## 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. It emits more than 400 Mt of carbon dioxide per year.

The National Climate Change Strategy, developed by the former 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 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. 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 emission 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 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 the 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 to be 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 utilising 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 are 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 already be carbon-capture ready. The engineering design will cater for this requirement.

## Energy and climate change

The Department of Environmental Affairs developed the Climate Change Strategy for the energy sector, which was scheduled for completion in 2009. The document will focus on GHG emissions and will support 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 is going to ensure that the Department of Energy contributes to mitigation efforts, and will position the department to address implications of international climate-change negotiations on the country's energy industry. The strategy will maximise potential benefits and minimise

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 will be addressed, not compromising economic growth and development and other environmental objectives.

### **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 ( $180 \text{ mg/m}^3$ ) by factors of six to seven during winter, and two to three in summer. A national programme has been established to introduce low-smoke energy alternatives into the townships.

Fuel wood is used by 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 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.

## Acknowledgements

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