SOUTH AFRICA YEARBOOK 2012/13

Energy

Energy is the vital force that powers business, manufacturing, the transportation of goods and the delivery of services to the nation. It is the lifeblood of modern living, as it has an impact on everything we do and affects our very existence.

South Africa's steady economic growth, coupled with an increasing focus on industrialisation and a mass electrification programme to take power into deep rural areas, has seen a steep increase in the demand for energy. In fact, South Africa's energy demand is expected to be twice the current levels by 2030.

The Department of Energy has, since its formation in 2009, been responsible for ensuring secure and sustainable provision of energy for socio-economic development.

With the cooperation of Eskom, the department has embarked on a massive programme to bring the electricity supply and distribution system into balance. At a cost of about R340 billion, Eskom is building new power stations, including Medupi in Limpopo that will make its first contribution to the energy grid by 2013, and Kusile, which will come on stream in mid-2014.

South Africa has always been heavily dependent on coal and although the country has ample supplies of coal, it is looking at ways to diversify its power-generating capacity.

Government is also looking to support sustainable green-energy initiatives on a national scale through a diverse range of clean-energy options as envisaged in the Integrated Resource Plan (IRP). In terms of this plan, which is a 20-year projection on electricity demand and production, about 42% of electricity generated must come from renewable resources. To this end, government has signed contracts to the value of R47 billion investing in the renewable energy programme. This involves 28 projects in wind, solar and small hydro technologies, to be developed in the Eastern Cape, Western Cape, Northern Cape and in the Free State.

In addition, government is continuing its Nuclear Energy Policy, which aims to increase the role of nuclear energy as part of the process of diversifying the primary energy sources to ensure energy security.

Government is also continuing the implementation of its energy efficiency programme for the industrial and domestic sector in line with the IRP to achieve the target for improved energy efficiency in South Africa of 12% by 2015.

As part of its energy efficiency strategy, government will also launch a public awareness campaign aimed at making energy efficiency an integral part of domestic, commercial and industrial activity.

Legislation and policies

The Department of Energy derives its mandate from the *White Paper on Energy Policy, 1998,* the *White Paper on Renewable Energy, 2003,* and the National Energy Efficiency Strategy.

The following legislation regulates the energy sector:

- The National Energy Act, 2008 (Act 34 of 2008), ensures that diverse energy resources are available in sustainable quantities and at affordable prices in South Africa. 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 Electricity Regulation Act, 2006 (Act 4 of 2006), establishes a national regulatory framework for the electricity supply industry to be enforced by the National Energy Regulator of South Africa (Nersa). The Minister of Energy is empowered to make determinations for the establishment of independent power producers (IPPs) to increase the supply of electricity.
- The Petroleum Products Act, 1977 (Act 120 of 1977), as amended, provides for measures in the saving of petroleum products and the economy in the cost of distribution, the maintenance and control of price, the furnishing of certain information regarding petroleum products and the rendering of service. It further provides for the licensing of people involved in the manufacturing, wholesale and retailing of prescribed petroleum products.
- The Central Energy Fund (CEF) Act, 1977 (Act 38 of 1977), as amended, provides for the determination of state levies.
- The Nuclear Energy Act, 1999 (Act 46 of 1999) provides for the establishment of the National Energy Corporation of South Africa (Necsa) and defines its functions, powers, financial and operational accountability, governance and management. It also regulates the acquisition and possession of nuclear fuel, nuclear and related material and equipment, and the import and export thereof.

Other relevant legislation include:

- National Nuclear Regulator (NNR) Act, 1999 (Act 47 of 1999)
- National Radioactive Waste Disposal Institute Act, 2008 (Act 53 of 2008)
- Petroleum Pipelines Act, 2003 (Act 60 of 2003)
- Petroleum Pipelines Levies Act, 2004 (Act 28 of 2004)
- Gas Act, 2001 (Act 48 of 2001)
- Gas Regulator Levies Act, 2002 (Act 75 of 2002)
- National Energy Regulator Act, 2004 (Act 40 of 2004)
- Electricity Act, 1987 (Act 41 of 1987), as amended
- National Environmental Management Act, 1999 (Act 107 of 1999)
- Mineral and Petroleum Resources Development Act, 2002 (Act 28 of 2002).

Legislation tabled in Parliament during 2011/12 included:

- Electricity Regulation Amendment Bill
- The National Energy Regulator Amendment Bill
- The Independent Systems and Market Operator Bill.

National Energy Efficiency Strategy

In November 2012, Cabinet approved South Africa's revised energy efficiency strategy. The strategy was initially approved by Cabinet in March 2005, and a review process was started in October 2008. The strategy sets the target for improved energy efficiency in South Africa at 12% by 2015.

The objectives of the strategy are to:

- promote and develop energy efficiency practices, norms and standards in different energy sectors, including industries, commercial buildings, households, transport and agriculture
- develop energy efficiency policies and guidelines
- facilitate information awareness, and capacity-building campaigns on energy efficiency and environmental issues
- promote energy for sustainable development
- mitigate negative impacts of energy use on the environment
- promote energy efficiency technologies and clean energy technologies including environmentally sound energy technologies
- promote and facilitate international collaboration and cooperation
- ensure the Department of Energy's participation at international forums on energy efficiency and the environment, including the United Nations (UN) Commission on Sustainable Development, the Kyoto Protocol and the UN Framework Convention on Climate Change.

The strategy includes Eskom's Demand Side Management (DSM). When a utility or local authority that supplies electricity influences the way it is used by customers, this activity is known as DSM. Municipalities are also implementing their own energy efficiency strategies.

In addition, 32 large companies have joined forces with the Department of Energy and Eskom by signing an energy efficiency accord, committing themselves to targets contained in the strategy.

To assist households in becoming more energy efficient, the Department of Energy initiated an appliance labelling campaign. Labels on household appliances inform consumers of the energy efficiency of the appliances. The Department of Energy, in collaboration with the Department of Public Works and Eskom, is retrofitting government buildings to make them more energy efficient. This contributes a saving of about R600 000 in electricity bills per year.

National building standards

Energy efficient regulations for new buildings form part of the deliverables of South Africa's National Energy Strategy to strengthen standards and regulations for energy efficiency.

The energy efficiency regulations apply to residential and commercial buildings, places of learning and worship, certain medical clinics and other categories of building. The regulations 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. This will save energy significantly, which will relieve pressure on the electricity supply grid.

In addition to temperature regulations, 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.

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 finalised and expected to be published for comments early in 2013.

It sets out 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.

National Liquid Petroleum Gas (LPG) Strategy

As part of the promotion of clean energy sources, an LPG Strategy 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.

The strategy will highlight strategic options that could be adopted for the orderly devel-

opment of the LPG industry in South Africa to make LPG an energy carrier of choice for thermal applications.

Budget and funding

The Department of Energy was allocated R6,8 billion in 2012/13, of which 95% (R6,5 billion) was transferred to the following:

- the Integrated National Energy Programme (Inep): R3,1 billion to connect 150 000 and 10 000 households to the grid and none-grid systems, respectively
- Energy efficiency and DSM programmes: R1 billion to accelerate the solar water heating programme
- the New Multiproduct Pipeline: R1,5 billion for the final instalment
- Necsa: R554 million to continue with its central role as the anchor for nuclear energy, research, development and innovation
- the balance will be used for smaller projects and transfers to state-owned entities (SOEs) reporting to the Minister of Energy as follows:
  - South African National Energy Development Institute (Sanedi): R50,1 million
  - NNR: R30,9 million
  - Renewable Energy Fund Subsidy Scheme: R40,4 million.

The operational budget comprised R307,27 million, a 0,06% increase from 2011/12.

Role players

National Energy Regulator of South Africa (Nersa)

Nersa regulates electricity, gas and petroleum pipelines in South Africa. It adopted high-level strategic objectives over the next three 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.

National Nuclear Regulator (NNR)

The NNR provides for the protection of people, property and the environment against nuclear damage, through the establishment of safety standards and regulatory practices. Strategic objectives between 2011 and 2014 include:

- 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.

Nuclear Energy Corporation of South Africa (Necsa)

Necsa is a public company and is wholly state-owned. Its functions are to:

- undertake and promote research into nuclear energy and radiation sciences and technology
- process source, special nuclear, and restricted material including uranium enrichment
- collaborate with other entities.

The Nuclear Energy Act, 1999 provides for the commercialisation of nuclear and related products and services, and delegates specific responsibilities to Necsa, 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 research and development and nuclear fuel-cycle responsibilities.

Necsa's main function is to serve as the anchor for nuclear energy research and development, and innovation in South Africa. The research focus is directed mainly at nuclear technology applications, such as:

- 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 research and development and to provide irradiation services for the production of medical radioisotopes
- decommissioning and decontaminating nuclear facilities
- 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.

In the medium term, Necsa will focus on:
- radiation research, products and services
- nuclear fuel research and development 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.

South African National Energy Development Institute (Sanedi)

Sanedi (previously Saneri) was restructured to expand its mandate to also promote energy efficiency initiatives and demand-side management. Additionally, it will house South Africa's carbon-capture and storage research and development, and other energy research programmes.

The original institute's mandate was to stimulate innovation in energy research and development, transform the gender and race profile of researchers in the sector, and improve South Africa's competitiveness in energy research internationally by procuring research, facilitating cooperation with others in the research community and commercialising innovations achieved under its auspices by disseminating research and development 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.

Central Energy Fund (CEF)

The CEF 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 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 research and development
- managing and optimally exploiting local strategic energy and related resources
- mitigating against environmental impacts and maximising sustainable development.

The Department of Energy and PetroSA launched an Integrated Energy Centre in Mbizana in the Eastern Cape in November 2012.

The centre is a one-stop shop offering services of energy goods. It will house an information centre, a convenience store, a car wash, an energy shop, ablution facilities and a fuels forecourt. Petrol, diesel, paraffin and liquid petroleum gas will be sold at the centre.

Previously, Mbizana residents had to travel at least 15 km to the nearest town to purchase every-day commodities such as electricity, petrol and diesel.

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 2010, the department reported challenges facing the Kuruman (Northern Cape) and Eshane (KwaZulu-Natal) IECs. The department, together with Total (Pty) Ltd and the municipalities in these areas, revived the projects, which were re-opened during 2011/12.

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.

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

On average, 60 temporary jobs are created during the construction phase of each IEC, and 10 permanent jobs once the centre is operational. Four new IECs were in development in 2012/13, and will contribute a further 240 construction-related jobs and 40 permanent jobs.

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, 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 retails 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.

In 2011/12 state-owned enterprises committed over R131 million to help fund social and community programmes, with the bulk of funding coming from Eskom and Transnet.

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

Sasol's energy cluster focuses on the manufacturing, refining and marketing of automotive and industrial fuels, oils and gas.

With partners in China, the company launched a feasibility study into a CTL plant with a potential capacity of around 80 000 barrels per day.

End products include petrol; diesel; jet fuel; fuel oil; illuminating paraffin; liquefied petroleum gas; pipeline gas; lubricants and greases; bitumen and naphtha.

Sasol's local energy cluster comprises the following:

- Sasol Oil: Handles crude oil refining activities as well as blending and marketing of liquid fuels and lubricants.
- Sasol Gas: Supplier of pipeline gas to industrial and commercial customers.
- Sasol Mining: Produces about 40 million tons (Mt) of saleable coal per year.
- Sasol Synfuels: Operates the coal-based synfuels manufacturing facility at Secunda, in Mpumalanga.

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 – the SADC countries connected to the South Af-

rican grid and the rest of Africa – is limited to those projects that have a direct impact on ensuring security of supply for South Africa.

National Nuclear Energy Executive Coordination Committee

In November 2012, Cabinet was briefed on the first meeting of the National Nuclear Energy Executive Coordination Committee, chaired by Deputy President Kgalema Motlanthe, to oversee any future nuclear procurement processes as well as the energy build programme.

It endorsed the proposed phased decision-making approach for implementation of the nuclear programme. It also endorsed the designation of Eskom as the owner-operator as per the Nuclear Energy Policy of 2008. Cabinet approved the Nuclear Communication and Stakeholder Engagement Strategy.

The Southern African Power Pool (SAPP)

The SAPP allows the free trading of electricity between SADC member countries, providing South Africa with access to the vast hydropower potential in the countries to the north, notably the significant potential in the Congo River (Inga Falls). SAPP has made it possible for members to delay capital expenditure on new plants due to the existence of interconnections and a power pool in the region. SAPP member countries are Mozambique, Botswana, Malawi, Angola, South Africa, Lesotho, Namibia, the Democratic Republic of Congo (DRC), Swaziland, Tanzania, Zambia and Zimbabwe.

Other role players

- iGas is the official state agency for the development of the hydrocarbon gas industry in southern Africa.
- PetroSA is a government-owned oil and gas company mandated by Cabinet to lead developments in gas infrastructure in the Western Cape.
- The Petroleum Agency of South Africa promotes the exploration and exploitation of natural oil and gas, both onshore and offshore, in South Africa and undertakes the necessary marketing, promotion and monitoring of operations.
- Petronet owns, operates, manages and maintains a network of 3 000 km of high-pressure petroleum and gas pipelines, on behalf of the government.

Energy resources

South Africa produces about 5% of its fuel needs from gas, about 35% from coal and about 50% from local crude oil refineries. About 10% is imported from refineries elsewhere in the world. The country has a sizeable capital stock and management capacity to produce fuel from gas. The Department of Energy's Hydrocarbons and Energy Planning Branch is responsible for coal, gas, liquid fuels, energy efficiency, renewable energy and energy planning, including the energy database.

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.

Liquid fuels

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.

South Africa faces a number of specific challenges in the liquid fuels sector:

Gas stocks for the existing gas-to-liquids plant from offshore fields are declining. South Africa should source sufficient feedstocks to support – and, ideally, increase – production. The best option to secure feedstocks would be to invest in gas fields close or adjacent to existing fields in the southern Cape, as marginal costs are lower and it will allow for further exploitation of existing fields, maximising use of existing capital. PetroSA is best placed to lead this petroleum refinery investment, given its existing capital and its management experience.

In the longer term, the Mossel Bay Refinery could use either liquefied natural gas imports or Karoo shale gas, if it becomes available. Refining capacity has run out and South Africa now has to import a share of its refined fuel needs. There are five options to deal with this, namely:

- building a new oil-to-liquid refinery (such as the proposed Mthombo Project in Coega)
- building a new coal-to-liquid refinery
- upgrading the existing refineries; allowing significant expansion of one or more of the existing refineries
- importing refined product
- building a refinery in Angola or Nigeria and buying a share of the product of that refinery.

The least risky and most cost-effective option is to continue importing a share of refined products until the country reaches a stage where it can absorb the output of either a new refinery or a major upgrade of an existing refinery. South Africa will, therefore, continue to import, taking a decision on the next step by 2016/17. Timing is important, given lead-time requirements to develop a new refinery (estimated at about eight to 10 years) that would be expected to produce output by 2025 to 2028 (if no other options are implemented).

Other issues related to liquid fuels include:

- Clean fuel standards: Health issues and the advent of new, more efficient automobile engines mean that South Africa needs to migrate to international clean fuel standards.
- Vehicle carbon tax: If South Africa adopted a consistent carbon price across the economy, and this price was around R100/t carbon, it would translate into an increase of only 5% at petrol pumps (compared to 20% for the electricity sector), thus sending only a weak signal to consumers to conserve petrol or diesel. A much more effective instrument would be a tax on vehicle sales based on their carbon-emission signatures.
- Electric vehicles: Over the next 20 years, South Africa can expect to see greater use of electric vehicles, making it even more vital to start decarbonising electricity generation. The Department of Energy has also encouraged a shift to greater use of public transport.

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

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 region of Gauteng. 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 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.

Oil and natural gas

South Africa has very limited oil reserves. About 60% of its crude oil requirements are met by imports from the Middle East and Africa.

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 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.

To this end, the IRP was developed, which incorporates gas among alternative energy sources for electricity generation. The IRP presents a 20-year view on South Africa's energy mix that seeks to balance growth in demand with South Africa's commitments to reduce its dependence on coal and to lower climate-changing emissions.

The IRP aims to:

- improve the country's global competitiveness
- support job creation
- improve management of natural resources
- reduce and mitigate greenhouse gas (GHG) emissions in line with commitments on reduction targets.

Cabinet's approval of the IRP and the tabling in Parliament of the Independent System and Market Operator Bill in March 2011 bode well for the facilitation of participation of IPPs in electricity generation in South Africa. Under the approved IRP, imported gas is expected to make up 6% of all new electricity generation, hydro power 6%, open-cycle gas turbines 9%, coal 15% and nuclear 23%.

This translates into 15% of electricity being obtained from gas. Natural gas accounts for 3% of the country's primary energy consumption.

Alternative gas resources

Experiments are underway to assess the potential for mining coal-bed methane gas, although the overall potential of this resource for producing electricity in South Africa is probably less than previously thought. Underground coal gassification technology is also being developed.

According to the United States of America (USA) Energy Information Administration, technically recoverable shale-gas resources in South Africa form the fifth-largest reserve globally. Confirmation of recoverable reserves is still necessary through further drilling of test wells. Even if economically recoverable resources are much lower than currently estimated, shale gas as a transitional fuel has the potential to contribute a very large proportion of South Africa's electricity needs.

In investigating the potential for accessing shale gas in the Karoo Basin in the Northern Cape, Cabinet decided that only normal exploration would take place until a proper and relevant regulatory framework had been put in place, and until government was satisfied that it could deal adequately with the consequences of the technique known as hydraulic fracturing.

Cabinet established a task team to evaluate the use of a hydraulic fracturing technique in the extraction of shale gas. This task team comprised representatives from the departments of environmental affairs, water affairs, science and technology, energy, mineral resources, the Petroleum Agency of South Africa, the Council for Geoscience, Square Kilometre Array (known as SKA) South Africa, the Water Research Commission and Eskom.

The task team, in turn, appointed a working group of experts that brought on board technical advisers and academics from the University of the Free State and University of the Western Cape, who served as a reference group.

This team was tasked with evaluating the potential environmental risks posed by the use of hydraulic fracturing as a method of extracting shale gas, and the negative and positive social and economic impacts of shale gas exploitation as identified in the Karoo Basin.

In August 2012, Cabinet approved the task team's report on the matter and lifted the moratorium on the processing of applications for exploration in the Karoo Basin. It was also made clear that this was conditional on the establishment of the appropriate regulations, controls and coordination systems, which is

expected to be in place by the end of 2013. Hydraulic fracturing will be authorised under the strict supervision of the monitoring committee. In the event of any unacceptable outcomes, the process may be halted.

There will be ongoing research, facilitated by relevant institutions, to develop and enhance scientific knowledge, including but not limited to geo-hydrology of the prospective areas, methodologies for hydraulic fracturing in South Africa and environmental impact.

Electricity

Results from *Census 2011* indicate that 84% of the 51,7 million people in South Africa has access to electricity.

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

To this end, more than R340 billion will be spent on Eskom's New Build Programme. This will bring on line a further 11 641 MW of new capacity in the short term, adding to Eskom's existing 40 000 MW of capacity.

Government's goal is to ensure that all South African households have 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.

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.

About 65% 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, while the rest is produced by open-cast methods. 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.

Renewable and alternative fuels

The Department of Energy has the sole mandate to promote the use of renewable energy, initiate projects to advance the use of renewable energy and annually monitor the precise

quantity of energy produced from renewable energy.

The *White Paper on Renewable Energy (2003)* has set a target of 10 000 GWh of energy to be produced from renewable energy sources (mainly from biomass, wind, solar and small-scale hydro) by 2013.

Following Cabinet approval of the White Paper, the Department of Energy proceeded with the development of its renewable energy strategy. The implementation plan of the various technologies was identified in a macro-economic study undertaken in 2003. The White Paper's target of 10 000 GWh renewable energy contribution to final energy consumption by 2013 was confirmed to be economically viable with subsidies and carbon financing. Achieving the target will:

- add about 1 667 MW of new renewable energy capacity, with a nett impact on gross domestic product as high as R1,071 billion a year
- create additional government revenue of R299 million
- stimulate additional income that will flow to low-income households by as much as R128 million, creating just over 20 000 new jobs
- contribute to water savings of 16,5 million kilolitres, which translates into a R26,6 million saving.

Renewable energy sources, other than biomass (the energy from plants and plant-derived materials), have not yet been exploited optimally in South Africa.

The vision of the Department of Energy is to make adequate and affordable energy available to developing communities through a mix of providing alternative energy resources at a reasonable cost. The aim is to satisfy the basic needs of the developing sector and at the same time promote the effective use of South Africa's vast alternative energy sources.

To monitor progress towards the White Paper's target of producing 10 000 GWh of energy from renewable energy sources by 2013, a monitoring and evaluation project has been set up.

Every year, the department collects data on renewable energy contributions from relevant stakeholders to assess or evaluate progress towards this goal.

The target can be achieved mainly from production of renewable energy by grid, off-grid (a source of energy not connected to a grid) and bio-fuel facilities. This renewable energy will be used for power generation to the grid and for water heating purposes.

The 10 000 GWh 2013 target would be equivalent to electrifying approximately two million households having an annual electricity consumption of 5 000 kWh. Put another way, the 10 000 GWh target is equivalent to about 5% of the present electricity generation in South Africa. This is equivalent to replacing two 660-MW units of Eskom's combined coal-fired power stations.

Biofuel

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.

South Africa has significant potential to develop a commercially viable biofuels sector notwithstanding the country's 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. If South Africa increased its blending target to 10%, some 125 000 direct jobs could be created, many of which would be based in rural areas, where poverty is widespread.

In September 2012, fuel company Total unveiled its first sustainable service station in Fairland, Johannesburg. Innovative eco-friendly features include natural lighting, enhanced ventilation, double-walled underground tanks, solar panels and energy-reducing glass for lower electricity consumption, easy-access recycling receptacles, and a water-harvesting facility that collects rainwater in underground tanks to use for the bathrooms, or to water the plants and rinse off the forecourt floor.

Hydro power

Energy from water can be generated from waves, tides, waterfalls and rivers and will never be depleted as long as water is available. South Africa has a mix of small hydro-electricity stations and pumped-water storage schemes.

Pumping uses some electricity, but this is done in off-peak periods. During peak hours, when extra electricity is needed, the water is released through a turbine that drives an electric generator. Peak hours are usually from 06:00 to 08:00 and 18:00 to 20:00.

South Africa used to import electricity from the Cahora Bassa hydropower station in Mozambique and will do so again once the transmission line is repaired. There is also the potential to import more hydropower from countries such as Zambia, Zimbabwe and Zaire. If this happens, South Africa could become less dependent on coal-fired power stations.

However, the generation of hydro-electricity is not without environmental effects; for example, large areas of land may be flooded when dams are built, which will disrupt wildlife habitats and residential and farming areas.

Global pressures regarding the environmental impact and displacement of settlements by huge storage dams will likely limit the exploitation of hydropower on a large scale. Irrespective of the size of its installation, any hydropower development will require authorisation in terms of the National Water Act 1998, Act 36 of 1998.

The Eastern Cape and KwaZulu-Natal are endowed with the best potential for the development of small, i.e. less than 1 MW, hydropower plants. These plants can either be stand-alones or 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.

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.

The Bramhoek and Bedford dams have both been completed and the R23-billion Ingula

Pumped Storage Scheme will be implemented during 2013/14. To date, 2 400 MW of capacity has been awarded to renewable projects.

In August 2012, Cabinet approved a draft treaty between South Africa and the DRC for the development of the Grand Inga Hydro-electric Project. The project on the Congo River could become the largest hydro-electric project in the world, and is expected to generate a massive 40 000 MW of electricity – more than the current electricity generation in South Africa, with the potential to supply clean and cost-effective hydroelectric power to meet the needs of the DRC and surrounding or nearby countries, including South Africa.

According to the IRP's 20-year projection on electricity supply and demand, about 6% of electricity generated in the country will be required to come from hydro resources.

Solar power

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 kWh/m^2 and 6,5 kWh/m^2 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^2 for South Africa, compared with about 150 W/m^2 for parts of the USA, and about 100 W/m^2 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 rapidly to meet demand. Annual photovoltaic panel-assembly capacity totals 5 MW, and a number of companies in South Africa manufacture solar water heaters.

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

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.

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

If 1% (1 940 km^2) 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 photovoltaic).

In November, Spanish renewable energy group Abengoa started construction on two concentrated solar power projects in South Africa. Abengoa, one of the 28 first-phase IPPs, will build a 50 MW solar power tower near Upington and a 100 MW parabolic-trough solar power plant near Pofadder, both in the semi-desert Northern Cape province.

The two plants will reduce South Africa's carbon dioxide emissions by about 498 000 t a year, while creating between 1 400 and 2 000 construction jobs and about 70 permanent operation jobs, as well as numerous indirect jobs to fulfil the needs required by the plant and its construction.

Wind power

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 would be sold to 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.

Construction on the first commercial wind farm at the Coega Industrial Development Zone, Port Elizabeth, in the Eastern Cape was expected to start in September 2012, and was expected to start supplying power by October 2013. The R550-million wind farm will be the first of its kind in the province. Nine 3-MW turbines will provide 80 million kWh a year to the local electricity grid, accounting for nearly half of Nelson Mandela Bay's 10% renewable energy target. It will provide electricity close to source to around 5 000 to 6 000 homes. Over the 20-year period of its licence, renewable energy company Metrowind will plough an estimated R50 million back into local communities, who will own a 5% stake in Van Stadens Wind Farm through a trust.

In November 2012, Ireland's Mainstream Renewable Power started construction on solar and wind power projects in the country, as part of a €500-million (about R5,5-billion) investment. Mainstream Renewable Power is one of the 28 IPPs that signed contracts with the South African Government in the first round of the Renewable Energy Independent Power Producer Procurement (REIPPP) Programme.

Mainstream Renewable Power and its partners will build a 138-MW wind farm in Jeffreys Bay in the Eastern Cape, and two 50 MW solar photovoltaic parks in the Northern Cape – one near De Aar and one at Droogfontein near Kimberley. All three projects are scheduled to be fully operational by mid-2014.

The projects are expected to produce 635 GWh of electricity, enough to supply up to 48 000 households and displace approximately 628 000 t of carbon emissions per year.

May 2012 saw the opening of the PetroSA Synthetic Fuels Innovation Centre at the University of the Western Cape. This is the country's first academic facility offering research on improving the quality of diesel. PetroSA, South Africa's national oil company, provided funding of R36 million to establish and operate the centre for an initial five-year research programme.

Hybrid systems

Hybrid energy systems are a combination of two or more renewable energy sources such as photovoltaic, wind, micro-hydro, storage batteries and fuel-powered generator sets to provide a reliable off-grid (a source of energy not connected to a grid) supply.

Currently, there are two pilot hybrid systems in the Eastern Cape at the Hluleka Nature Reserve on the Wild Coast and at the neighbouring Lucingweni community.

The Hluleka hybrid mini-grid system consists of two proven 2,5 kW wind generators and three Shell solar photovoltaic module arrays

fitted with 56 100-watt photovoltaic modules wired in series (total 10,6 kW). An integrated design approach, which resulted in a joint energy, water purification and telecommunication system, was followed. The energy system makes use of renewable energy (wind and solar), solar water heaters and LPG. One diesel generator is retained for back-up supply. The Hluleka system has been in operation since June 2002.

The Lucingweni hybrid system consists of 50-kW solar photovoltaic panels and 36-kW wind generators serving 220 dwellings (four lights per dwelling, radio, television, mobile phone charger, street lighting, telecommunications and water pumping).

Tradable renewables

The *White Paper on Renewable Energy Policy* proposed that tradable renewable energy certificates be investigated to find out whether these could be one of the funding streams to support the implementation of the renewable energy programme in South Africa. This would be in addition to other funding options, i.e. sale of physical electrical power through a power purchase agreement into the electrical grid at prevailing electricity (energy) market prices and certified emission reductions trading through the clean development mechanism (CDM), a UN framework mechanism that encourages developing countries to implement emission-reduction projects to earn certified emission reductions.

A tradable renewable energy certificate is an electronic record that verifies the origin of energy by a registered renewable energy entity. It is also referred to as a green certificate or green tag. Tradable renewable energy certificates are based on separating the various attributes of renewable resource-based energy provision from the physical energy carrier, electric or otherwise. It is another revenue stream for renewable energy IPPs and its major advantage is that, apart from potential extra income, certificates can be traded worldwide and separately from the electricity grid infrastructure.

The 49M Campaign launched in 2011, is aimed at challenging South Africans to be more energy efficient by reminding them that they have the power to make a difference. For Earth Hour on 31 March 2012, 49M encouraged people to save energy by switching off all unused electricity appliances. A total of 402 MW was saved – enough electricity to power the city of Mangaung in the Free State for a day.

By May 2012, the campaign had reached more than 40 000 South Africans in one-on-one conversations and over seven million people through the above-the-line campaign.

Nuclear

Nuclear energy is set to play a critical role in South Africa's IRP implementation process. For this reason the National Nuclear Energy Executive Coordination Committee was established in 2011 as the authority for decision-making, monitoring and ensuring general oversight of the nuclear energy expansion programme.

The success and deployment of nuclear power requires public acceptance, and public education is the most important topic surrounding nuclear energy.

Concerns regarding the safety of nuclear energy in view of the Fukushima incident in Japan in 2011, when an earthquake and subsequent tsunami damaged a nuclear power plant, causing nuclear meltdown and the release of radioactive materials, were factored into the South African approach. Proper safety measures were put in place and overseen by the appropriate expert authorities. As a member of the International Atomic Energy Agency, South Africa is obliged to comply with the relevant guidelines and safeguards on nuclear plants.

The nuclear sector in South Africa is mainly governed by the Nuclear Energy Act, 1999 (Act 46 of 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 Group 3 and Group 4 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's Directorate: Radiation Control issues licences for Group 3 hazardous substances (electronic product generating X-rays, other ionising beams, electrons, neutrons or other particle radiation or non-ionising radiation) and Group 4 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 radio-isotopes.
- 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 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 the Women in Nuclear South Africa Programme to promote the industry among historically disadvantaged people.

In May 2012, South Africa's Anglo American Platinum (Angloplat) launched the prototype of the first fuel-cell-powered underground locomotive.

Hydrogen-powered fuel-cell locomotives are more economical and environmentally friendly than traditional rail transport, as it is powered by a cleaner and more secure energy source.

A fuel cell is essentially a gas battery that produces electricity as long as it is fed with hydrogen gas. Power is available for 24 hours per day with no need to change or recharge the battery. This means less downtime and increased productivity.

Programmes and projects

The Integrated Resources Plan (IRP)

By 2030, the department aims to have reduced the country's dependency on coal to 60%, with the rest of the country's power coming from low-emitting sources such as solar, hydro and nuclear.

If successfully implemented, the IRP will see South Africa diversify its mix of power sources away from coal, which is currently where the country gets about 90% of its power, and at the same time double its energy output.

Despite the increase in output, the decrease in coal burning will result in a nett reduction of

carbon dioxide emissions by 2030 to less than 275 Mt a year, and a 60% reduction in water usage.

The IRP 2 was approved by Cabinet in March 2011. Renewable energy sources make up 42% of projected new and additional capacity to be added over the period, and will constitute 9% of installed capacity by 2030.

The IRP laid the foundation for the country's energy mix up to 2030, and sought 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, lead time to build
- water usage
- localisation and job creation
- southern African regional development and integration
- security of supply.

The IRP 2 provides for a diversified energy mix, in terms of new generation capacity, that would 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 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 at 2,4% and photovoltaic at 19,7%.

Progress thus far constitutes 1 415 MW of Phase 1 of a total of 3 725 MW to be procured by 2016. Some 97 environmental authorisations were approved during the first bidding phase of the REIPPP, which represents in excess of 10 454 MW. In its first roll-out phase, the REIPPP will see an initial 1 400 MW of renewable energy being added to South Africa's energy mix, while bringing an estimated R47 billion in new investment into the country.

A total of 4 MW of solar photovoltaic capacity was installed in the country in the lead-up to Conference of the Parties (COP17), which took place a the end of 2011, by Eskom, IPPs and municipalities as part of a carbon offset and legacy programme.

The South Africa Renewables Initiative was launched at COP17 as an international partnership to support the rapid and ambitious scaling up of renewable energy in a manner that delivers economic, social and environmental benefits.

In addition, amendments to building regulations to promote the use of renewable energy and thermal efficiency have been finalised.

Approximately 200 000 solar water heating units were installed between 2009 and December 2011, towards the target of one million units by 2014. Of these, 70% have been installed in rural areas and 30% in the higher-income areas. It is envisaged that the balance of the target will be funded by an electricity tariff increase in the period 2012 to 2014.

Regarding objectives set for the green economy under the New Growth Path, the implementation of the IRP will make a significant contribution to stimulating the domestic green economy.

Over 12 000 construction-related and more than 1 000 permanent jobs are expected to be created under the programme.

Renewable Energy Independent Power Producer Procurement (REIPPP) Bidding Programme

The flagship programme under the IRP is the REIPPP Bidding Programme for the provision of 3 625 MW of capacity from IPPs.

In December 2011, 28 preferred independent renewable power producers was announced, comprising 18 solar photovoltaic projects, eight onshore wind projects and two concentrated solar power projects. All projects must be generating power by mid-2014.

The department then initiated a fresh bidding round for other technologies such as cogeneration from biomass, including sugar and paper, biogas, landfill gas, and small hydro. The 19 selected preferred bidders in this second round were announced in May 2012.

In September 2012, it was announced that the third bidding round for small power or less than 5 MW-capacity bidding were postponed to May 2013.

In November 2012, Government signed agreements with the 28 first-window IPPs. This would see an initial 1 400 MW of renewable energy being added to South Africa's energy mix, and bring an estimated R47 billion in new investment into the country. While the majority of the bidders are foreign companies, 67 South African companies formed partnerships with them.

The projects are spread across some of South Africa's most rural and least developed provinces, including the Eastern Cape, Northern Cape, Limpopo, North West and the Free State.

The wind and solar projects are expected to be integrated into the country's national energy grid during 2014.

Bidders also committed to community development initiatives within a 50-km radius of each project. The bidders have collectively committed R2 billion towards socio-economic development, and R1 billion towards empowering women in the energy field.

In total, these bidders will spend R12 billion over the duration of the implementation agreements on South African contractors.

Integrated National Electrification Programme (Inep)

The Department of Energy began funding Inep in April 2001, with Eskom implementing the programme 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.

Inep is a modern energy option and also 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 electrification programme, 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.

In 2011/12, the electrification programme was allocated R3,119 billion, with municipalities receiving R1,151 billion and Eskom R1,882 billion, while R86 million was allocated for non-grid connections. This catered for the planned 192 000 grid and non-grid connections for the year.

For bulk infrastructure projects, R345 million was allocated to municipalities and R243 million to Eskom.

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.

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.

In May 2012, South Africa launched its first verified wind atlas, which maps out potential hotspots as a tool for wind-farm developers as the coal-hungry country pushes toward renewable energy. The atlas models the wind climate in the Northern, Eastern and Western Cape provinces, which is backed up by measured data from 10 masts.

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.

Two new coal power stations are under construction – the 4 800-MW Medupi Power Station near Lephalale in Limpopo and Kusile in Mpumalanga, which is also expected to have an output of 4 800 MW.

Medupi is scheduled for full commercial operation by 2015 and Kusile by 2018, although individual units will be brought online earlier as they are completed.

On 8 June 2012, the Hydrostatic Pressure Test for Unit 6 at the Medupi Power Station was unveiled. The test was undertaken to ensure that the boiler was fully functional and ready to start generating electricity for South Africa's national grid. Medupi, the first coal-fired power station to be built in South Africa in 20 years, is due to make its first contribution to the grid at the end of 2013.

The boiler and turbine contracts for Medupi are the largest contracts that Eskom has signed in its 87-year history. The planned operational life of the station is 50 years. It is one of the largest construction sites in the Southern Hemisphere, employing about 17 000, with about 40 000 job opportunities expected to be created by the new power station.

When complete, Medupi will be the world's largest dry-cooled coal-fired plant. It will incorporate super-critical machinery, which can operate at higher temperatures and pressures than older-generation equipment, and is also more efficient, resulting in better use of natural resources and lowered impact on the environment. The super-critical design is Eskom's first.

Kusile, on the other hand, will be the first power plant in South Africa to have cutting-edge fuel gas desulphurisation technology installed. This means that its exhaust gases will be processed to remove all traces of sulphur oxides before being released into the atmosphere. Excess sulphur dioxide in the air is one of the causes of acid rain.

South Africa's energy demand is expected to be twice the current levels by 2030. Once all six units are completed, Medupi will be able to produce enough electricity to power almost all of Gauteng.

In May 2012, Hydro Alternative Energy from Florida in the United States of America announced negotiations with the City of Durban to develop a project that would harvest hydrokinetic energy from the fast-flowing Agulhas current off the KwaZulu-Natal coastline. The current is one of the most consistent currents in the world, making Durban an ideal location to harness it. Generating electric power from sea currents has never been done before; with all previous sea and wave generation technologies being tidal-based.

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 Mt per year of 95% concentration carbon dioxide.

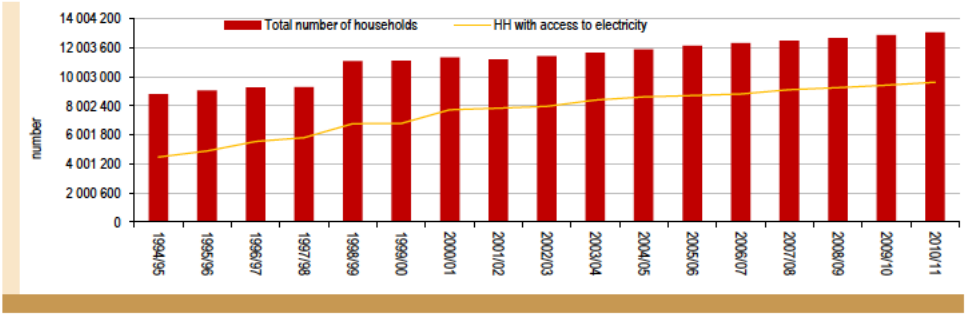
- The Carbon Dioxide Geological Storage Atlas, launched in August 2010, will locate and characterise potential storage sites at a theoretical level and on a geological basin extent. The atlas will then be taken into the South African Centre for Carbon Capture and Storage's programme of work and be developed to locate a storage site suitable for a test injection. Pre-atlas knowledge had identified four possible carbon-dioxide geological storage basins:
  - Orange Basin (offshore of the west coast)
  - Outeniqua Basin (offshore 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

HOUSEHOLDS WITH ACCESS TO ELECTRICITY

	1996/97	1998/99	2000/01	2002/03	2004/05	2006/07	2008/09	2009/10	2010/11
1.Total number of households	9 258 000	11 077 100	11 320 614	11 429 819	11 891 395	12 317 505	12 675 275	12 860 165	13 068 953
2. HH with access to electricity	5 544 968	6 774 207	7 735 748	7 959 862	8 610 706	8 819 835	9 245 357	9 419 466	9 624 445
%	59.9%	61.2%	68.3%	69.6%	72.4%	72.0%	74.5%	74.9%	75.8%
3. HH with no access to electricity	3 713 032	4 302 893	3 584 866	3 469 957	3 280 689	3 497 670	3 429 918	3 440 699	3 444 508
4. New electrical connections(cumulative)	1 432 073	2 302 789	3 036 726	3 654 060	4 144 214	4 452 758	4 930 101	5 097 423	5 300 250

HOUSEHOLDS WITH ACCESS TO ELECTRICITY



Definition	Number of households connected to grid electricity through Eskom and municipalities. Household figures based on Department of Energy's projection using census data
Data source	1-4) National Electricity Regulator of South Africa; Statistics South Africa Department of Energy
Data note	The difference in household figures is due to the different methodologies used by the departments where data is sourced vis a vis the various surveys conducted by Statistics SA. The backlog figures has also considered growth (in informal settlements and low cost housing), for an example Gauteng Province look less in terms of access to electricity because of growth (in informal settlement).

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 CO_2 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.

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, educational and empower communities.

In 2011/12, the department allocated R25 million for this project, which is implemented by Sanedi.

Designated National Authority (DNA) for Clean Development Mechanism (CDM)

The Department of Energy is mandated to regulate and promote the implementation of a CDM in South Africa. This is done to make sure that South Africa complies with its obligations under the Kyoto Protocol and the UN Framework Convention on Climate Change.

As custodian of CDM, the DNA is responsible for ensuring that CDM investments are in line with sustainable development objectives and that South Africa benefits from the CDM.

In 2011/12, the DNA received and reviewed 58 clean development project proposals; 52 project identification notes and six project design documents.

Two projects were registered with the CDM's executive board. These were the Ekurhuleni Land-fill Gas Recovery Project, which has the potential of ensuring a reduction of 243 629 t of carbon dioxide equivalent (CO_2) a year, and the Fuel Switch Project on the Gluten 20 dryer of the Germiston Mill of Tongaat Hulett Starch Pty (Ltd), which has the potential of reducing 8 360 t of CO_2 a year.

By the end of 2011/12, South Africa had 19 registered projects, six of which had been issued with certified emission reductions amounting to 1,7 Mt of CO_2. The CDM uptake was slow, mainly because of the complexities associated with the CDM project cycle. The DNA conducted programmes to raise awareness and to build capacity in this area.

Liquid Fuels Roadmap

As a result of the identified constraints throughout the liquid fuels supply chain, the Department of Energy embarked on a pro-

Construction of the two terminals that complete the first phase of freight logistics group Transnet's New Multi Product Pipeline (NMPP) is on track, The mechanical, electrical, instrumentation and piping work started in January 2013.

The terminals – one in Heidelberg and the other in the Cutlet Complex at Island View in Durban – are expected to be completed by the end of 2013. The NMPP is a key strategic investment for South Africa that will ensure the supply of petroleum products to regions.

Once complete, the NMPP will have capacity to carry five products, namely 95 and 93 unleaded petrol, 500 and 50 PPM diesel, and jet fuel.

cess to develop a Liquid Fuels Infrastructure Roadmap. A key objective of this roadmap is to ensure that South Africa has access to reliable, affordable, clean, sufficient and sustainable sources of energy to meet the country's liquid fuel demand.

In addition, in dealing with the supply challenges of refineries, in 2012 the department conducted an audit of the country's refineries to assess the state of the refineries and to obtain an understanding of their current capacity.

A preliminary investigation indicated that South Africa's refineries are experiencing reduced production levels, which is equally a threat to liquid fuels security of supply.

The 20-Year Liquid Fuels Infrastructure Plan

The 20-Year Liquid Fuels Infrastructure Plan will form the basis for the implementation of the Presidential Infrastructure Coordinating Commission Strategic Implementation Project regarding refinery upgrades and development, and will make recommendations on the future of the refinery infrastructure in the country.

As a further response to the global situation and domestic development imperatives, the department decided to strengthen the Strategic Fuels Fund (SFF), a subsidiary of the CEF. A new SFF board with the requisite complement of skills and a new chief executive officer were expected to be appointed by the end of 2012. The Department of Energy will position the SFF to improve the country's strategic petroleum reserves and enable the country to better respond to catastrophic global events that impact on the petroleum trade.

Renewable energy programmes from Eskom

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.

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 was underway in 2012.

Sere Wind Farm

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. The Sere Project will go into commercial operation towards the end of 2013.

Ingula Pumped Storage Scheme

Another project is the 1 333-MW Ingula Pumped Storage Scheme in KwaZulu-Natal, with a roll-out cost of R23 billion.

This plant comprises two dams that are connected via an underground powerhouse, with four 333-MW pump turbines. Each dam has a capacity of roughly 22 million m³. Water will flow from the upper dam to the lower in peak times, generating power as it passes through the turbines, and when the demand is low the turbines will pump the water back to the upper dam.

The Ingula Pumped Storage Scheme is scheduled to come on line in 2014 and add 1 332 MW of hydro power to South Africa's electricity grid, as well as making a significant contribution to job creation and rural development.

Underground coal gassification

Eskom also has an underground coal gassification project in the pilot stage, with a test plant next to Majuba Power Station in Mpumalanga. The gas produced is co-fired with coal in Majuba's Unit Four, and contributes 3 MW to the station's output.

When the pilot plant delivered its first batch of gas to Majuba in October 2010, Eskom made history as the event marked the first production of commercial electricity from underground coal gassification outside the former Soviet Union.

The process entails using coal seams that cannot be mined for various reasons – they may be too deep, or fractured, or of poor quality – and turns the coal into clean gas on site. With the region's substantial coal reserves, there is potential in this source of power. Eskom has developed a 10-year transmission development plan which includes renewable energy integration.

Concentrated solar power

A solar park is a concentrated zone of solar plants that are built in clusters, sharing common transmission and infrastructure. Together, these clusters generate thousands of megawatts of electricity. The types of technologies used are solar photovoltaic and concentrated photovoltaic, which operate with semiconductors and solar panels, as well as concentrated solar power, which uses mirrors to reflect the sun's rays.

Photovoltaic systems make a direct conversion into electricity, and are ideal to use at peak load times. The only drawback is that there is no cost-effective way to store this power, so it is only viable when the sun is shining.

Concentrated solar power, on the other hand, captures the sun as heat and turns it into steam to power turbines, which in turn generate electricity – much like coal-fired plants. Its advantage is that it is cheap and efficient to store heat, so power can be supplied around the clock.

According to the Department of Energy, about 15 300 jobs will be created through the solar park to boost the economy of the Northern Cape, where there are high levels of unemployment. The park will also diversify the province's industry profile, which is currently limited to mining and agriculture.

South Africa's first solar plant of its kind was unveiled in October in Ekurhuleni, Gauteng.

The solar power plant, situated at the environmentally friendly OR Tambo Precinct in Wattville outside Benoni, produces about 200 kW of electricity through 860 photovoltaic solar panels on 2 500 m² of land, generating enough energy to power about 133 low-cost houses.

Energy produced by the solar pant will be connected to the grid using 18 inverters and one combiner unit.

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 encouraged 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.

The CFLs were distributed free to consumers across the country in exchange for their existing incandescent bulbs. The environmentally friendly light bulbs, which used to cost between R60 and R80 each, came down in price in 2011 to about R15 per bulb on average.

The campaign has been remarkably effective. Its highlights included:

- between 2007 and 2012, more than 30 million CFLs were distributed free of charge to South Africa
- more than seven million tons of CO_2 emissions were saved
- more than 30 000 jobs were created.

Between 2011 and 2014, the CFL Sustainability Programme is to distribute between 20 million and 40 million CFLs.

By November 2012, Eskom had distributed 54 million light bulbs.

International cooperation

Sustainable development in Africa

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 hydro-electric energy of the Inga rapids site in the DRC 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. Inga III, a 3 500-MW hydro plant on the Congo River, will be the first of these projects.

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).

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 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 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 is proactively moving 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 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.

The Grand I MoU signed with the DRC is an important milestone in working towards sustainable African partnerships aimed at developing strategies for low-carbon economies and interconnected energy systems.

The Tete-Maputo Power Transmission Line, also known as the Centre-South Project (Cesul), in Mozambique, will improve the ability to evacuate power from the projects in the northern Mozambique complex, particularly releasing the hydropower potential relating to Mpanda Nkuwa and Cahora Bassa, among others.

The South African Renewables Initiative secures international financing partnerships in investment in deploying renewable energy; and develops renewable supply chains through securing a critical mass of renewable energy, without imposing undue burden on the fiscus or the South African consumer.

In line with this objective, the Department of Energy has signed a Declaration of Intent with Germany, the United Kingdom, Denmark, Norway and the European Investment Bank. This agreement will lead to the establishment of a fund to assist in the deployment of renewable energy.

Further, the department participates in structures such as the:

- International Renewable Energy Agency
- International Energy Forum
- International Partnership for Energy Efficiency Cooperation
- UN Industrial Development Organisation
- Clean Energy Ministerial
- African Union-European Union Energy Partnership.

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.

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.

At a bilateral level, the Department of Energy signed seven agreements/declarations of intent with the International Energy Agency, the Swiss Confederation, Ghana, Lesotho, Denmark, Korea, and the DRC.

These agreements cover access to capacity-building, funding, technology, exchange of information and development of energy infrastructure on the continent with the objective of increasing generation capacity.

Conclusion

With South Africa's growing population and increasing need for energy, the Department of Energy is continuously working towards ensuring energy security, achieving universal

access, transforming the energy sector and ensuring the optimal use of energy resources.

A great deal has been achieved during the last financial year. Some milestones include:

- the construction of the New Multiproduct Pipeline
- the launch of the energy efficiency campaign
- installation of more than 250 000 solar water heater systems
- completion of the wind atlas, which accurately quantifies the country's wind energy resources
- signing of seven bilateral agreements and declarations of intent, covering areas of cooperation in capacity-building, funding, technology and infrastructure.

By 2020, it is envisaged that:

- coal rail capacity will match coal export port capacity at Richards Bay
- the Kusile coal-fired power station will be commissioned and at least 7 000 MW of renewable energy will be contracted, mostly from private IPPs
- liquefied natural gas infrastructure will be in place to power the first combined-cycle gas turbines
- pro-poor electricity tariffs will be better targeted to include all qualifying electricity customers
- electrification coverage will reach at least 85%, with affordable access to complementary energy sources that include solar water and space heating
- a decision will be made on whether South Africa should continue importing petroleum products or invest in a new refinery.

Goals beyond 2020 include contracting more than 20 000 MW of renewable energy, including an increasing share from regional hydroelectricity. About 11 000 MW of Eskom's older coal-powered stations will be decommissioned, but close to 6 000 MW of new coal capacity will be contracted – part of it from other southern African countries.

Long-term goals also include the promotion of cleaner coal technologies through research and development investments, and technology-transfer agreements.

The extent of economically recoverable coalbed seam and shale gas reserves will also be better understood. Subject to acceptable environmental controls, these gas resources, supplemented by liquefied natural gas imports, will begin to supply a growing share of power production. This could avoid the need for further base-load nuclear generation.

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

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