

A photograph of a high-voltage electrical substation. The image shows several tall metal lattice towers supporting multiple high-voltage power lines. The lines are strung across the towers, and there are various electrical components like insulators and transformers visible. The sky is blue with some light clouds. The right side of the image is partially obscured by a large orange graphic element.

South Africa Yearbook 2015/16

Energy

The Department of Energy (DoE) is mandated to ensure the secure and sustainable provision of energy for socio-economic development. This is achieved by developing an integrated energy plan, regulating the energy industries, and promoting investment in accordance with the integrated resource plan. The department's strategic goals are to:

- ensure that energy supply is secure and demand is well managed
- facilitate an efficient, competitive and responsive energy infrastructure network
- ensure that there is improved energy regulation and competition
- ensure that there is an efficient and diverse energy mix for universal access within a transformed energy sector
- ensure that environmental assets and natural resources are protected and continually enhanced by cleaner energy technologies
- implement policies that adapt to and mitigate the effects of climate change
- implement good corporate governance for effective and efficient service delivery.

The DoE places emphasis on broadening electricity supply technologies to include gas and imports, as well as nuclear, biomass and renewable energy resources (wind, solar and hydro), to meet the country's future electricity needs and reduce its carbon-dioxide emissions.

Goals beyond 2020 include contracting more than 20 000 megawatts (MW) of renewable energy, including an increasing share from regional hydro-electricity.

South Africa has committed to attain substantial reductions in CO₂ emissions by 2025. The country supports research, technology development and special measures aimed at environmentally sustainable economic growth.

Legislation and policies

The DoE 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 to save petroleum products and the economy in distribution costs, 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 includes the:

- 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)
- Electricity Regulation Amendment Act, 2007 (Act 28 of 2007).

National Energy Efficiency Strategy

The National Development Plan (NDP) envisages that by 2030 South Africa will have an adequate supply of electricity and liquid fuels to ensure that economic activity and welfare

are not disrupted, and that at least 95% of the population will have access to grid or off-grid electricity.

The NDP proposes that gas and other renewable resources such as wind, solar and hydro-electricity will be viable alternatives to coal and will supply at least 20 000 MW of the additional 29 000 MW of electricity needed by 2030.

Other recommendations in the NDP include diversifying power sources and ownership in the electricity sector, supporting cleaner coal technologies, and investing in human and physical capital in the 12 largest electricity distributors.

The DoE will continue to address these proposals through a combination of new and existing programmes.

Funds will continue to be allocated to the South African National Energy Development Institute (Sanedi) for research and development into a carbon capture and storage project, and for a hydraulic fracturing pilot to assess the potential for shale gas.

The DoE will also continue implementing the pilot approach to the distribution asset management programme, by providing capital subsidies to nine municipalities to address maintenance, refurbishment and backlog concerns to improve the quality of electricity supply.

The objectives of the revised energy efficiency 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 concerning 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 DoE'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). Municipalities are also implementing their own energy efficiency strategies. In addition, 32 large companies have joined forces with the DoE 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 DoE initiated an appliance-labelling campaign. Labels on household appliances inform consumers of the energy efficiency of the appliances. The DoE, in collaboration with the Department of Public Works (DPW) and Eskom, is retrofitting government buildings to make them more energy efficient.

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-efficient 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 South African national standards.

National Liquid Petroleum Gas (LPG) Strategy

LPG is commonly used in mines to power smelting furnaces that are processing materials, such as platinum and vanadium, as well as domestically for cooking.

The LPG 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 highlights strategic options that could be adopted for the orderly development of the LPG industry in South Africa to make LPG an energy carrier of choice for thermal applications.

The domestic LPG price is regulated through the DoE by the Minister of Energy.

Budget and funding

The DoE's budget allocation increased from R7.44 billion in 2014/15 to R7.48 billion in 2015/16.

The original indicative allocation of R7.98 billion in 2015/16 was adjusted downward to R7.48 billion by incorporating the following adjustments during the 2015 MTEF budget process:

- Compensation of employees: reduced by R22.1 million
- Goods and services: reduced by R15.59 million
- Payments for capital assets – reduced by R235 000
- Transfer payments: net reduction of R488.43 million made up of:
 - Conditional grants to municipalities: reduced by R86.16 million
 - Departmental agencies (transfers to entities): net-reduction of R47.16 million
 - Public corporations and private enterprises: net reduction of R338.48 million
 - Membership fees to foreign entities – increase of R4.13 million

During the 2015 Adjusted Estimates of National-Expenditure process (AENE), the Department's 2015 final budget allocation of R7.48 billion was adjusted downwards to R7.27 billion. The factored adjustments were:

- An additional amount of R35.53 million rolled over from the 2014/15 financial year to the 2015/16 financial year to finalise payments carried over from the previous financial year in respect of the Integrated National Electrification Programme (INEP) Non-Grid Project's implementation.
- A budget reduction of R250 million from the National Solar Water Heater Programme (NSWHP) as savings identified by the National Treasury.

Role players

National Energy Regulator of South Africa

NERSA is a regulatory authority established as a juristic person in terms of Section 3 of the National Energy Regulator Act, 2004 (Act 40 of 2004). NERSA's mandate is to regulate the electricity, piped-gas and petroleum pipelines industries in terms of the Electricity Regulation Act, 2006 (Act 4 of 2006), Gas Act, 2001 (Act 48 of 2001) and Petroleum Pipelines Act, 2003 (Act 60 of 2003).

Revenue is generated from tariffs and levies paid by the regulated industries. The total revenue for the 2015/16 financial year amounted

to R315 692 722 million.

NERSA has formulated the following five strategic outcome-oriented goals:

- facilitate security of supply to support sustainable socio-economic development in South Africa
- facilitate investment in infrastructure in the energy industry to support sustainable socio-economic development in South Africa
- promote competitive and efficient functioning of the energy industry in order to sustain socio-economic development in South Africa
- facilitate affordability and accessibility in the energy industry to balance the socio-economic interests of all stakeholders in support of economic development of South Africa and a better life for all
- position and establish NERSA as a credible and reliable regulator in order to create regulatory certainty.

National Nuclear Regulator

The NNR is responsible for the protection of people, property and the environment against nuclear damage.

Nuclear Energy Corporation of South Africa

NECSA is a wholly state-owned company. 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 of 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 focuses mainly on 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 radio-isotopes
- decommissioning and decontaminating nuclear facilities
- implementing the Nuclear Non-Proliferation Treaty and the Comprehensive Safeguards Agreement with the International Atomic Energy Agency (IAEA); 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

National Radioactive Waste Disposal Institute (NRWDI)

The National Radioactive Waste Disposal Institute Act, 2008 (Act 53 of 2008) provides for the establishment of the NRWDI in order to manage radioactive waste disposal on a national basis.

Operations include:

- designing and implementing disposal solutions for all classes of radioactive waste;
- developing radioactive waste acceptance and disposal criteria in compliance with applicable regulatory health, safety and environmental requirements and any other technical and operational requirements;
- assessing and inspecting the acceptability of radioactive waste disposal facilities, including related storage and predisposal management of radioactive waste at disposal sites;
- managing, operating and monitoring operational radioactive waste disposal facilities, including related storage and predisposal management of radioactive waste at disposal sites;
- managing and monitoring closed radioactive waste disposal facilities;
- investigating the need for new radioactive waste disposal facilities and site selection, design and construction of such new facilities as may be required;

- conducting research and developing plans for the long-term management of radioactive waste storage and disposal;
- maintaining a national radioactive waste database and publishing a report on the inventory and location of all radioactive waste in the Republic at a frequency determined by the Board;
- managing the disposal of any ownerless radioactive waste on behalf of the state, including the development of radioactive waste management plans for such waste;
- assisting generators of small quantities of radioactive waste in all technical aspects relating to the disposal of such waste;
- implementing any assignments or directives from the Minister regarding radioactive waste disposal.

South African National Energy Development Institute

Sanedi is mandated 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.

Operations includes:

- undertaking measures to promote energy efficiency throughout the economy;
- ensuring uninterrupted supply of energy to the country;
- promoting diversity of supply of energy sources;
- facilitating effective management of energy demand and its conservation;
- promoting energy research;
- promoting appropriate standards and specifications for the equipment, system and processes used to produce, consume and supply energy;
- providing for certain safety, health and environmental matters that pertain to energy;
- facilitating energy access to improve the quality of life of the people of the Republic;
- commercialising energy-related technologies;
- ensuring effective planning of energy, supply, transportation and consumption, and contributing to the sustainability of development of the South African economy.

Central Energy Fund

The CEF finances and promotes the acquisition of research into and exploitation of oil, gas and renewable/clean energy-related products and technology.

Undertakings include:

- involvement in the search for appropriate

energy solutions to meet the future energy needs of South Africa, the SADC and sub-Saharan region, including oil, gas electricity, solar energy, low smoke fuels, biomass, wind and renewable energy sources;

- management of the operation and development of the oil and gas assets and operation of the South African Government;
- finance and promotion of the acquisition of coal, the exploitation of deposits and the manufacture of liquid fuel, oil and other products from coal;
- marketing of said products and any matter connected with the acquisition, exploitation, manufacturing and marketing thereof;
- management of 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 give tariff protection to the synthetic fuel industry
- acquisition, generation, manufacture, marketing or distribution of any other forms energy and research connected with.

Integrated energy centres (IECs)

The DoE, in collaboration with oil companies, have since 2002 been establishing the IECs in poverty nodal areas around the country as part of the Department's mandate to promote access to energy services, such as petroleum products in rural areas where the volumes of sales are too low for a normal commercial operation to be established.

The objectives of the IEC Programme are to:

- provide access to safe and affordable energy resources to poor households
- provide information regarding the safe, efficient and environmentally-sustainable use of energy sources and available energy options such as renewable and non-grid energy
- enable a strong social responsibility aimed at poverty alleviation, job creation and capacity building
- stimulate rural economy

By mid-2016, there were seven operating IECs and the construction of two new IECs in Bushbuckridge and Qamatha was expected to be completed in the second quarter of 2016/17.

An IEC is a one-stop energy supplier, owned and operated by the community cooperative and organised as a community project.

It provides energy solutions to communities; access to affordable, safe and sustainable energy services; information and awareness on how to handle and use energy services such as paraffin and LPG and small, medium and micro enterprise development through partnerships

with key stakeholders, such as the National Development Agency and the Department of Trade and Industry.

The six IECs are: Kgalagadi and Moshaweng in Kuruman, Northern Cape; Eshane in Greytown, KwaZulu-Natal; Caba Mdeni in Matatiele and Mbizana, Eastern Cape; Mutale in Thohoyandou, Limpopo; and Ratlou in Makgobistad, North West.

Sasol

Sasol is a leader in various energy fields, including the Sasol Slurry Phase Distillate Process (SPD process). Through this process, natural gas is transformed into energy and chemical products, including transport fuels, base oils, waxes, paraffin and naphtha.

The company develops and commences Sasol is expanding internationally based on a unique value proposition. The company is listed on the JSE Limited in South Africa and on the New York Stock Exchange in the United States of America (USA).

The company is one of the world's largest producers of synthetic fuels. It mines coal in South Africa and produces natural gas and condensate in Mozambique, oil in Gabon and shale gas in Canada.

Sasol continues to advance its upstream oil and gas activities in West and southern Africa, the Asia Pacific region and Canada. In South Africa, Sasol refines imported crude oil and sells retail liquid fuels through its network of some 400 service stations and supplies gas to industrial customers. It also supplies fuels to other licensed wholesalers in the region.

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, which handles crude oil refining activities as well as the blending and marketing of liquid fuels and lubricants.
- Sasol Gas, which supplies pipeline gas to industrial and commercial customers.

- Sasol Mining, which produces about 40 million tons (Mt) of saleable coal a year.
- Sasol Synfuels, which operates the coal-based synfuels manufacturing facility at Secunda, in Mpumalanga.

Eskom

Eskom is one of the top utilities in the world by generation capacity. It generates approximately 95% of the electricity used in South Africa and approximately 45% of the electricity used in Africa. Eskom directly provides electricity to about 45% of all end-users in South Africa. The other 55% is resold by redistributors, including municipalities.

Eskom generates, transmits and distributes electricity to about five million customers in the industrial, mining, commercial, agricultural and residential sectors, and to redistributors. Eskom sells electricity directly to about 3 000 industrial customers, 1 000 mining customers, 49 000 commercial customers, 84 000 agricultural customers and more than four million residential customers (of whom the majority are prepaid customers). Most of the sales are in South Africa, with other southern African countries accounting for a small percentage.

Additional power stations and major power lines are being built to meet South Africa's rising demand for electricity. Recent successes have been the commercialization of the Sere wind farm (100MW) in March 2015, and the synchronisation of the first unit (794MW) at Medupi Power Station in August 2015. By mid-2016, more than 6 000 km of new transmission lines had been built and over 30 000 MVW in new substation capacity had been added to strengthen the national power network.

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). The 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 Angola, Botswana, the Democratic Republic of Congo (DRC), Lesotho, Malawi, Mozambique, Namibia, South Africa, 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 DoE's Hydrocarbons and Energy Planning Branch is responsible for coal, gas, liquid fuels, energy efficiency, renewable energy and energy planning, including the energy database.

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.
- 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 CTL refinery
 - upgrading the existing refineries; allowing significant expansion of one or more of the existing refineries
 - importing refined products
 - building a refinery in Angola or Nigeria and buying a share of the product of that refinery.

Other issues related to liquid fuels include:

- clean fuel standards
- vehicle carbon tax
- electric vehicles

- 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 Gauteng. This requires investments in storage and distribution facilities for the supply of petroleum products at the point of need.

The construction of the new multi-product pipeline, which was funded under the DoE through Transnet, was completed. The new 555-km pipeline, which has a 70-year design life, runs from Durban to Gauteng. It can transport jet fuel, 93-grade and 95-grade unleaded petrol, low-sulphur diesel and ultra-low-sulphur diesel.

The trunk pipeline, with pump stations, terminals and a 160-km inland pipeline network, came into operation at the end of 2013, increasing capacity from the existing 4,4 billion litres to 8,4 billion litres.

These mega infrastructural projects and related support infrastructure require a close and ongoing partnership between state-owned enterprises 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).

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 DoE 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 Integrated Resources Plan

(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 the management of natural resources
- reduce and mitigate greenhouse gas (GHG) emissions in line with reduction targets.

In August 2013, South Africa's state-owned oil and gas company PetroSA launched a R15-million geoscience collaboration, visualisation and technology centre, which will prove a boost to gas exploration and drilling. Geoscientists, engineers and technical officials will be able to collaborate in the Ulwazi (Knowledge) Collaboration and Visualisation Centre, which is equipped with various screens and computers that can display 3D imaging of subsurface formations. This will make it possible to take better informed and faster decisions when drilling for gas.

The centre can also be used daily to monitor and guide drilling operations for PetroSA's gas drilling project Ikhwezi located off the East Coast to sustain its GTL refinery in Mossel Bay.

Using data fed back from drilling bits on such things as sand or rock type or the resistivity of the substance being drilled, officials will also be able to adjust where exactly to drill, compare data from old drilling sites and make changes to the angle or direction of its active drill bits.

This is particularly useful to the Ikhwezi project where horizontal drilling is taking place 1,5 km along the basin at a depth of four kilometres from the surface.

Alternative gas resources

Experiments are underway to assess the potential for mining coal-bed methane gas.

Underground coal gassification technology is also being developed.

According to the USA Energy Information Administration, technically recoverable shale-gas resources in South Africa form the fifth largest reserve globally.

Since the publication of draft regulations on shale gas development, substantive inputs have been received from interested and affected stakeholders. The regulations to guide shale gas exploration were at a consultation stage by November 2014.

In August 2014, government said it was ready

to regulate and monitor companies that had expressed an interest in exploring shale gas in the country.

The Department of Mineral Resources first halted new applications for exploration rights in 2011 to investigate the impact that the process would have on the environment, and an interdepartmental task team was set up to head this process.

Government is clear that shale gas will form a part of the energy mix going forward.

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

Electricity

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.

In December 2014, the departments of energy, cooperative governance and traditional affairs, public enterprises, national treasury, economic development, water and sanitation and Eskom – as well as technical officials were overseeing the implementation of government's five-point plan to address the electricity challenges facing the country.

Government said the five-point plan would address the strain the electricity system faces.

The five-point plan covers:

- the interventions that Eskom will undertake
- harnessing the cogeneration opportunity through the extension of existing contracts with the private sector
- accelerating the programme for substitution of diesel with gas to fire up the diesel power plants
- launching a coal independent power producer programme
- managing demand through specific interventions within residential dwellings, public and commercial buildings and municipalities through retrofitting energy efficient technologies.

To meet the country's future energy requirements, government is implementing an energy mix which comprises coal, solar, wind, hydro, gas and nuclear energy. In future, biomass, wind power,

solar power and hydro-power will contribute 11,4 Gigawatts of renewable energy to the grid.

Biomass for energy is restricted due to water availability in South Africa but energy from waste, using the estimated 60 to 70 million m³ of waste generated annually, is more readily available and exploitable. (SAIREC2015)

Coal

South Africa's indigenous energy-resource base is dominated by coal.

By international standards, South Africa's coal deposits are relatively shallow with thick seams, making them easier and cheaper to mine. At the present production rate, it is estimated that there more than 50 years of coal supply left.

Coal provides for about 65% of South Africa's primary energy needs. 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.

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

On renewable energy such as solar and wind, the DoE has procured over 3 900 MW of renewable energy with about 1 000 MW already in operation and 1 400 MW planned to come online during 2016.

Work is underway to procure the remaining megawatts in line with the IRP 2010. About 2 500 MW has been allocated for coal programme procurement from IPPs.

Work on the Grand Inga Project to secure 2 500 MW is continuing, while an energy agreement between South Africa and the DRC has been signed.

The agreement, which was signed in September 2014, provides a legal framework for cooperation between the two countries.

The Medupi Power Station Unit 6 synchronization was on track for the end of December 2014, with grid connection and full operation was around June 2015.

Biofuel

South Africa has remained a peripheral participant in the international biofuel sector's growth. There are several reasons for this:

- Being a relatively new sector, there are various complex regulatory barriers 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 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.

South Africa set the beginning of October 2015 as the date from which fuel producers would have to blend diesel and petrol with biofuels.

Fuel producers would be required to blend a minimum of 5% biodiesel in diesel and between 2% and 10% of bioethanol in petrol.

Biofuels are expected to reduce the country's reliance on imported fuel.

The biofuels industry in South Africa, the continent's biggest agricultural producer, has been held back by an inadequate regulatory regime and concerns that biofuels would hurt food security and affect food prices.

Canola, sunflower and soya are feedstock for biodiesel, while sugarcane and sugar beet are feedstock for ethanol.

The Government said maize, South Africa's staple food, could not be used in the production of biofuels to ensure food security and control high prices.

Hydropower

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 hydroelectricity 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 DRC, which could make South Africa less dependent on coal-fired power stations.

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.

Eskom is continuing resource surveys of the Agulhas Current on the east coast of South Africa and of wave energy, in partnership with the DEA and the Bayworld Centre for Research and Education.

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

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

South Africa boasts one of the best solar regimes in the world. Most areas in the country average more than 2 500 hours of sunshine per year, and average daily solar-radiation levels range between 4,5 kWh/m² and 6,5 kWh/m² in one day. The southern African region and in fact the whole of Africa, is well endowed with sunshine all year round. The annual 24-hour global solar radiation average is about 220 W/m² for South Africa. The solar resource is the most readily accessible in South Africa. It lends itself to a number of potential uses.

In November 2014, SolarReserve, a global developer of solar power projects and solar thermal technology, announced that the 96 MW photovoltaic (PV) Jasper solar power project is fully operational.

Jasper is located in the Northern Cape in a solar park that also includes the 75 MW Lesedi solar power project, which came online in May 2014.

In addition to helping South Africa meet its electricity needs, the Jasper Project will bring long lasting economic benefits to the region.

With over 325 000 PV modules, the Jasper Project will deliver 180 000 MW-hours of renewable electricity annually for South African residents.

The power generated is enough to power up to 80 000 households through a 20-year power purchase agreement with Eskom.

The project also marked Google's first renewable energy investment in Africa – the Internet search invested US\$12 million in the solar project.

In August 2014, China-based solar PV giant, Jinko Solar, has officially opened a state-of-the-

art factory in Cape Town, creating 250 jobs and producing 1 300 solar PV modules a day.

Wind power

The R3-billion Jeffrey's Bay wind farm, located between the towns of Jeffreys Bay and Humansdorp in the Eastern Cape, was officially inaugurated in July 2014.

Built by a consortium led by British company Globeleq, the 138 megawatt (MW) wind farm is one of Africa's biggest - larger than the 120 MW Ashegoda windfarm that was unveiled by Ethiopia in October 2013, though not as big as the Tarfaya wind farm in south-western Morocco, which started producing energy in April and will eventually generate up to 300 MW of electricity.

The Jeffrey's Bay wind farm, comprising sixty 80-metre high turbines spread over 3 700 hectares, will supply enough clean, renewable electricity to power more than 100 000 homes a year, helping South Africa to avoid production of 420 000 tonnes of carbon dioxide annually.

The facility was built under the government's renewable energy programme for independent power producers, which aims to add 3 725 MW of wind, solar photovoltaic and concentrating solar power to South Africa's energy mix.

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 supply.

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.

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 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.

Nuclear

South Africa's vision for nuclear power is based on the Nuclear Energy Policy of 2008 that provides a framework within which the following is to take place: prospecting, milling, mining, the use of nuclear materials, and the development and utilisation of nuclear energy for peaceful purposes.

Government remains firmly committed to an open, fair and transparent procurement process with due regard to implementing the programme at a scale and pace that our country can afford.

The RFP for the Nuclear New Build Programme (NNBP) of 9 600 MW will be released to the market during the 2016/17 financial year in line with the Cabinet decision taken on 9 December 2015.

A Section 34 Ministerial Determination in terms of the National Energy Regulator Act, 2004 (Act 40 of 2004) on the NNBP was also gazetted in December 2015.

As part of procurement preparation for the NNBP, the Department has appointed Transaction Advisors to conduct an independent assessment of the RFP and other pre-procurement activities in order to ensure the state of readiness before testing the market.

In March 2016, Eskom, the owner and operator of the nuclear plants, as part of the regulatory process submitted a final Environmental Impact Assessment to the Department of Environmental Affairs for approval. In addition, a Nuclear Installation Site Licence Application had been submitted to the NNR for assessment.

Extensive nuclear skills development and training is taking place both in South Africa and in countries abroad to ensure that the country has a sufficient supply of skills and expertise to meet the human resource needs required by the NNBP.

Government remains committed to ensuring energy security for the country through the rollout of the NNBP as an integral part of the energy mix to provide reliable and sustainable electricity supply as part of mitigating the risk of carbon

emissions. The NNBP will enable the country to create jobs, develop skills, create industries and catapult the country into a knowledge economy.

The nuclear sector in South Africa is mainly governed by the Nuclear Energy Act, 1999 (Act 46 of 1999) and the NNR Act of 1999. The DoE administers these Acts.

The Nuclear Energy Expansion Programme is a central feature of South Africa's future energy mix, given the need to provide base load electricity and also meet the significant greenhouse gas emissions reduction target set for South Africa. The NNBP is expected to respond to job creation needs by creating employment and fighting poverty. It will also provide assurance to the investors for the security of energy supply for industrial purposes.

The DoE has done significant work around the NNBP since the preparatory work has commenced for the deployment of at least 9 600 MW of nuclear power fleet by 2030.

This is in line with IRP for 2010, which will ensure that the South African socio-economic vision defined in the NDP up to 2030 is realised.

Programmes and projects

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.

Wind Resource Map

The DoE launched the country's first Large Scale High Resolution (250 m) Wind Resource Map in July 2013. The data is based on the Verified Numerical Wind Atlas for South Africa (WASA). It includes important information such as ground surface terrain effects that determine the local wind climate and, in turn, can be used to identify high-yielding wind development zones; and the estimation of available wind energy and capacity which can be used by prospective wind farm developers of all sizes in their planning process.

The Wind Resource Map offers important benefits for planners, policy makers and industry. These benefits include cost and timing savings as the viability, in terms of wind speed, of a potential site can be predicted with known and traceable accuracy, while it also levels the playing field between small or large industry players to identify and develop project sites for wind farms.

It will also assist government in calculating the potential yield of wind energy resources, among other things.

The Large Scale High Resolution Wind Resource Map is available to the public from the WASA's online portal <http://wasadata.csir.co.za/wasa1/WASAData>.

The purpose of the WASA is to improve knowledge and the quality of resource assessment methods and tools, to make available this knowledge and tools free of charge for planning and development of wind farms and off-grid electrification, and to build capacity of local institutions to do wind resource measurements.

The country has a reasonable wind energy resource (an average of 8 m/s measured at 80 m) is available in geographically dispersed locations, allowing for security of supply. (SAIREC2015).

Integrated Resources Plan

The IRP 2010 – 2030 envisages 9 600 MW additional nuclear capacity by 2030. The IRP is a 20-year projection on electricity supply and demand. It aimed to reduce South Africa's primary reliance on fossil fuels such as coal and diesel, and diversify the national energy mix to produce 41.8% from renewable energy sources and a further 6.1% from hydroelectricity within two decades. (SAIREC2015).

Renewable Energy Independent Power Producer Procurement Programme (REIPPP)

The REIPPPP has been a flagship programme of the DoE. New generation capacity determinations made by the Minister of Energy under Section 34 of the Electricity Regulation Act, 2006 include:

- 13 225 MW of renewable energy (comprising of solar photovoltaic [PV]: 4 725 MW, wind: 6 360 MW, CSP: 1 200 MW, small hydro: 195 MW, landfill gas: 25 MW, biomass: 210 MW, biogas: 110 MW and the Small-Scale Renewable Energy Programme: 400 MW).
- 2 609 MW of hydroelectric power imports. The Small-Scale Renewable Energy Programme procured renewable energy from small-scale Independent Power Producers (IPP), with projects that are between 1 and 5 MW in size. Since the inception of the REIPPPP, the DoE has been successful in:
 - Increasing the contribution of clean energy from 0% in 2010 to over 4,5% within five years.
 - Creating 24 965 job-years of employment opportunities for South African citizens,

where a job-year is defined as the equivalent of a full time employment opportunity for one person for one year. To date, a total of R53 million has been contributed to enterprise development by operating IPPs. The programme has also broadened Broad-Based Black Economic Empowerment (B-BBEE), as Black South Africans own, on average, 30% of these projects.

In line with the national commitment to transition to a low carbon economy, and the IRP, it is expected that 17 800 MW of the 2030 target will be generated from renewable energy sources, with 5 000 MW to be operational by 2019 and a further 2 000 MW (combined 7 000 MW) operational by 2020.

In order to adhere to these targets and the power invested in the Department, the following new capacity determinations have been made:

- 13 225 MW of renewable energy (comprising of solar PV: 4725 MW, wind: 6 360 MW, CSP: 1200 MW, small hydro: 195 MW, landfill gas: 25 MW, biomass: 210 MW, biogas: 110 MW and the small-scale renewable energy programme: 400 MW)
- 2 500 MW designated from coal-fired plants (excluding cross-border projects)
- 1 800 MW of cogeneration
- 3 126 MW of gas-fired power plants
- 2 609 MW of imported hydro.

Over the past four years, REIPPPP has successfully connected 43 REIPP to the grid, which has added an additional 2 350 MW capacity to the national grid. The total projects costs invested in the Windows currently been announced is R192.6 billion. A minimum ownership by local communities in an IPP of 2.5% is required as a procurement condition.

In this way, a substantial portion of the investments has been structured and secured as local community equity. An individual community's dividends earned will depend on the terms of each transaction corresponding with the relevant equity share.

By mid-2016, all shareholding for local communities has been structured through the establishment of community trusts. For projects in Bid Window (BW) BW1 to BW4 and 1S2, qualifying communities will receive R29.2 billion net income over the life of the projects, which is 20 years. The R30.7 billion spent on B-BBEE during construction for BW1 and BW2 already exceeded the R26.6 billion that had originally been anticipated by IPPs.

Integrated National Electrification Programme

INEP and its implementing agencies – Eskom, municipalities and non-grid service providers – have made remarkable progress in increasing access to electricity in South Africa and have connected over 6,7 million households between 1994 to March 2016.

Access to electricity is at 88% since 1994. R5.6 billion has been appropriated by 2015/16 financial year on the Electrification Programme, to delivering 260 000 connections utilising both grid and non-grid technologies. At the end of March 2016, INEP achieved 231 012 (grid) and 25 076 (non-grid) connections. This results in a total of 256 088 new connections as part of the 2015/16 financial year allocations.

The Non-Grid Electrification Programme has progressed well in the last financial year and has over achieved its target by achieving 25 076 connections. Since the inception of Non-Grid Electrification Programme, INEP achieved more than 123 379 installations of non-grid systems mainly in the Eastern Cape, KwaZulu-Natal, Northern Cape and Limpopo.

Non-grid systems consisting of solar cells converting sun energy into electrical energy are now also being considered for implementation in urban areas of the country with a view of increasing the basic electricity services in the informal settlements.

The EU is also assisting the Department to develop a sustainable delivery model and sustainable non-grid entities around the country. INEP has also developed the first draft of the Electrification Master Plan (EMP) to ensure better cooperation between the different implementing entities, as well as different technologies, and grid and non-grid roll-out in un-serviced areas, to ensure that universal access is reached by 2025/26.

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

On 30 August 2015, President Jacob Zuma officially opened one of six generating units at the Medupi Power Station in Lephalale in Limpopo, which contributes about 800 MW to the grid.

Kusile Power Station is scheduled for full commercial operation by 2018, although individual units will be brought online earlier as

they are completed. Kusile is a six-unit coal fired power station that will generate approximately 4 800 MW of electricity.

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 CO₂ sources and storage sites. The results of that investigation, released in 2004, showed that South Africa had capturable emissions and potential storage sites. Preliminary investigation identified that the synfuel industry in South Africa produced 30 Mt per year of 95% concentration CO₂.
- 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 developed to locate a storage site suitable for a test injection. Pre-atlas knowledge had identified four possible CO₂ 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 are subject to low permeability and also to dolerite intrusions.

Consequently, further investigation is required as to how CO₂ could be stored in these less favourable formations.

The Karoo Basin is the closest to the major sources of CO₂ emissions.

- The CO₂ Test Injection Experiment of safely injecting CO₂ 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 CO₂ 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 CO₂ into South African geological formations. The magnitude of the demonstration plant is in the order of hundreds of thousands of tons of CO₂ per year.
- If positive outcomes of the demonstration plant ensue, a full-scale commercial plant is envisaged. This phase will depend on the outputs of the previous phases.

Working for Energy Programme

The Working for Energy Programme is a social programme mainly intended to provide energy services derived from renewable resources to rural and urban low-income houses. In this manner it facilitates job creation, skills development, community-based enterprise development and the emancipation of youth, women and people with disabilities.

It is an integral part of the Expanded Public Works Programme. The programme was conceived in 2008/09 and transferred by the DoE to Saneri.

The major focus area is the provision of sustainable energy solutions (supply side) with special emphasis on the youth, women and people with disabilities in rural areas and low-income urban communities in terms of:

- labour-intensive options, targeting short-term employment opportunities
- sustainable employment opportunities, and enhancing stimulated local economic activity
- community development initiatives and cross-cutting human capital development.

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. The DoE 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.

Sere Wind Farm

Eskom's Sere Wind Farm was completed in 2015 and is delivering 100 MW to the national grid.

Ingula Pumped Storage Scheme

The Ingula Pumped Storage Scheme near Van Reenen in KwaZulu-Natal, consists of an upper and a lower dam; both with the capacity to hold about 22 million cubic metres of water capacity.

The dams, 4,6 km apart, are connected by underground waterways, through an underground powerhouse accommodating 4 x 333-MW pump turbines.

During times of peak energy consumption, water will be released from the upper dam through the pump turbines to the lower dam to generate electricity.

During times of low-energy demand the pump turbines are used to pump the water from the lower dam back up to the upper dam. The project came on line during 2013/14. The synchronisation of the first 2 units of the Ingula pumped storage scheme was expected to take place in 2016.

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.

The process entails using coal seams that cannot be mined for various reasons – they may be too deep, 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 technology used are solar PV and concentrated PV, which operate with semiconductors and solar panels, as well as concentrated solar power, which uses mirrors to reflect the sun's rays.

PV systems make a direct conversion into electricity, and are ideal to use at peak load times. However, there is no cost-effective way to store this power.

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.

International cooperation

South Africa is a member of the International Energy Forum (IEF) which aims to foster greater mutual understanding and awareness of common energy interests among its members.

The 74 member countries of the Forum are signatories to the IEF Charter, which outlines the framework of the global energy dialogue through this intergovernmental arrangement.

South Africa is a member state of the International Renewable Energy Agency (IRENA). IRENA seeks to make an impact in the world of renewable energy by maintaining a clear and independent position, providing a range of reliable and well-understood services that complement those already offered by the renewable energy community and gather existing, but scattered, activities around a central hub.

The country has been a member of the International Atomic Energy Agency (IAEA) for decades

and has been both a recipient and provider of services emanating from the agency.

As a member state of the IAEA, permanent member of the Board of Directors and actively participating in nuclear energy, safety, technology, security and disarmament, South Africa has contributed to efforts of ensuring that nuclear energy is used for peaceful purposes like power generation as well as medical, industrial and agricultural initiatives.

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 obtained from the Inga rapids site in the DRC to ensure the security of supply in the SADC.

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

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 South African economy depends greatly on fossil fuels for energy generation and consumption, and is therefore, 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 DoE 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.

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 DoE 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, due 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, Lesotho, Namibia and Swaziland.

