



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 (CO₂) emissions.

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

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.

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

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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 department aims to bring IPPs into the market when the Independent System and Market Operator Bill of 2012 is signed into law.

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 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. The National Strategic Fuels Stock Policy. It sets out the framework for the storage of fuel stock by government and the industry. It aims to ensure uninterrupted supply of petroleum products throughout South Africa by providing adequate strategic stocks and infrastructure such as storage facilities and pipeline capacity.

Strategic stocks are to be used during declared emergencies. The Minister of Energy will have the power to decide when a shortage of fuel and oil is at such a level to warrant an emergency.

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

In 2014/15, the department was allocated a total budget of R7,4 billion. A significant portion of the department's budget, 57% and 27%, was earmarked for the implementation of the electrification programme and the Clean Energy programme respectively. For electrification, the department makes transfer payments to Eskom and municipalities through the Integrated National Electrification Programme (Inep).

During Eskom's National Electricity Safety week in August 2014, illegal power connections have come under the spotlight. An electricity connection is illegal when any connection is made to the Eskom network without Eskom's permission. This can range from connecting to a mini-substation to connecting a neighbour through a personal meter or electricity board. Communities can immediately report unsafe electricity connections to 08600 37566 or 0800 112 722 and by reporting electricity theft to Operation Khanyisa by sending an SMS to Crime Line on 32211. The service is completely anonymous and costs only R1/SMS. Illegal connections are dangerous for several reasons, the most common of which is the lack of safety features associated with the connections. When untrained professionals make electrical connections, the cables often lack protective insulation. In addition, illegal connections are not suspended at a safe height above ground. This means that children, animals and even adults often touch these unprotected wires accidentally, causing electrocution, which can cause injury or even fatalities.

To help protect children, Eskom encourages parents to ensure their children:

- Avoid playing near power lines or substations.
- Do not fly kites near power lines. If a kite gets stuck in a power line, do not try to retrieve it; you could be hurt.
- Never climb trees or other structures near power lines.

These transfers are used to fund infrastructure for the electrification of households such as the building of substations, as well as upgrading of electrical networks. The Clean Energy programme, which is mainly responsible for the Energy Efficiency Demand Side Management programmes, also makes transfers to Eskom for the implementation of the National Solar Water Heater programme and to municipalities for the installation of energy-efficient lighting and technologies. The balance of the budget (16%) is allocated for Energy Policy and Planning, Petroleum and Petroleum Products Regulation and Nuclear Energy.

Between 2011/12 and 2013/14, R9,6 billion was allocated to Inep for electricity infrastructure, R3,6 billion to municipalities and R5,8 billion to Eskom for grid connections. The non-grid connections received a total of R296,5 million. As a result of the infrastructure investment over this period, 612 949 households received new electricity connections. In the period 2002 to 2014/15, 84 896 households were supplied with non-grid technology (Solar panels – Renewable Energy). Non-grid electrification programmes will in future be extended to cover areas country-wide and not only be implemented in concessionary areas.

Over the medium term, electrification infrastructure spending is expected to increase from R4,2 billion in 2014/15 to R6,3 billion in 2017/18, which will be used to implement grid electricity connections of 260 000 units in 2015/16, 265 000 in 2016/17 and 285 000 in 2017/18. In addition, 20 000 non-grid connections in 2015/16, 20 000 in 2016/17 and 25 000 in 2017/18 will be implemented. During the same period, it is planned that 15 new substations will be built while 18 are upgraded.

Although the department has six entities reporting to the Minister of Energy, in 2014/15, the DoE made transfer payments to three of these entities to fund their the operations. These are the:

- Sanedi
- Necsa
- Nnr.

Collectively, transfer payments to these three entities accounted for 13% of the department's total 2014/15 budget allocation.

R162,7 million was transferred to Sanedi to fund its operational expenditure as well as undertake research related to hydraulic fracturing and carbon capture and storage. The two nuclear energy entities, Necsa and NNR, received R760,7 million and R33,7 million respectively.

Transfers to the three entities continue over the medium term. From 2015/16 to 2017/18, R145,3

million will be transferred to Sanedi, R1,8 billion to NECSA and R76,7 million to the NNR.

Infrastructure spending is expected to increase to R5,7 billion in 2015/16.

In 2014/15, a total of R40 billion in infrastructure grants was transferred to local governments for their water, sanitation, energy and environmental functions.

The private sector was also making an increasing contribution to infrastructure investment. Contracts for 47 renewable energy projects were concluded in 2012 and 2013, many of which are already under construction.

These added 2 460 MW of power capacity, and an investment of R70 billion. A further R45 billion investment was contracted in 2014/15.

The construction of the Medupi and Kusile power stations had progressed, with Medupi set to deliver power in 2014 and Kusile in 2015.

The Ingula pumped storage scheme will be Eskom's third such scheme with an output of 1 332 MW, mostly used during peak demand periods. Investment in these three projects was estimated at R250 billion.

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). The structure of the energy regulator consists of nine members, five of whom are part-time, and four full-time, including the Chief Executive Officer.

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

In August 2014, women in the energy sector came together to take stock of the challenges and successes of South African women at the Women's Seminar, which was a partnership between consulting company Mzesi Academy, the Department of Energy and the Nuclear Energy Corporation of South Africa, among others. The aim of the seminar was to demystify the nuclear industry, given that it is a complex one. Many developments can be expected in the nuclear field as South Africa increases its investment in the industry.

- 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 radioisotopes
- 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.

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.

Central Energy Fund

The CEF's spending focus over the medium term is on accelerating spending on infrastructure, as well as the development of renewable and alternative energy sources. Projects incorporated over the medium term include Ikhwezi, with a total approved budget of R11,2 billion; Sabre Oil and Gas in the Jubilee Production Field, with a total budget of R4 billion; and Irene and other downstream acquisitions, with a total estimated cost of R14 billion.

Other projects to be undertaken are Project Mthombo, and projects in Venezuela and Equatorial Guinea. Project Mthombo is a PetroSA initiative to build a world-class crude refinery in the Coega Industrial Development Zone (IDZ) in the Eastern Cape. The initiative in Equatorial Guinea is a drilling project, while the project in Venezuela relates to the acquisition of a mature field opportunity. This accounts for the strong growth in acquisition of assets over the medium term.

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 to:

- manage the energy business for the benefit of all South Africans

- play an active role in the governance and planning of all its subsidiaries and coordinating the long-term future of the group
- improve security of energy supply by diversifying sources, and building and managing strategic energy stocks and energy infrastructure
- develop and invest in renewable and alternative energy sources and in energy efficiency
- develop human capacity and invest in relevant research and development
- manage and optimally exploit local strategic energy and related resources
- mitigate against environmental impacts and maximise sustainable development.

Integrated energy centres (IECs)

Government has identified access to energy for people in areas of greatest need as an urgent requirement to facilitate socio-economic development. One of the many approaches that the DoE has developed to address energy poverty through deliberate interventions in the second economy is the IECs programme.

The department is partnering with relevant stakeholders, the private sector, municipalities and communities in establishing the IECs. As a result, this is a public-private partnership venture.

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.

In June 2014, Sasol said its synthetic fuels production year-on-year was stable, as it announced plans to build a plant in the USA with Ineos Group. Ineos and Sasol plan to build a high-density polyethylene plant in La Porte, Texas, that will start in 2016 and produce 470 000 t of the material used in pipes, bottles and containers annually.

Sasol planned to make a final investment decision in 2014 on an ethane cracker project in Westlake, Louisiana, and a gas-to-liquids plant at the site 24 months later.

The GTL plant would be the first of its kind in the USA.

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

In October 2014, Eskom's Medupi power station project received its boiler registration certificate. This was the first of the six Medupi units that was synchronised with the national electricity grid in December 2014.

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 2014, South Africa took a leading global position in the conversion of sunlight into electricity through the development of new generation thin-film photovoltaic technology. This technology was fully developed in South Africa and is now produced at Technopark, Stellenbosch.

The PTiP demonstration plant is now used to demonstrate the advantages of the new technology to the world. In terms of cost and quality, the technology and product can compete with any similar product world-wide.

Electricity resellers have an important role to play in property management. Municipalities have created the need for resellers by implementing a policy of supplying only one electricity meter per property. The internal distribution to multiple end-users became the responsibility of the developer and later the landlord or body corporate. In the last few years some municipalities have introduced bulk domestic tariffs at which the resellers may buy the electricity and reseller tariffs at which they are supposed to sell the electricity to domestic end-users. The City of Tshwane is at the forefront of this and the energy regulator Nersa has recently compelled the metropolitan councils to accommodate resellers in their tariff structure.

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 is ready to regulate and monitor companies that have 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 inter-departmental 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.

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

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/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.

Jinko Solar opened this facility in response to the roll out of the South African REIPPP where 1484MW of solar PV projects have been procured. Since the inception of this programme, Jinko Solar has deployed over 300MW of solar PV panels, reaching approximately 30% market share.

The opening of Jinko's state-of-the-art production facility in Cape Town highlights the attractiveness of South Africa as an investment destination. It will contribute further to establishing the country as a hub for renewable energy and other green economy industries.

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

In November 2014, South Africa held its second nuclear vendor parade with China, France, the USA and South Korea.

South Africa's nuclear energy policy was approved in 2008 and was further enhanced by the approval of the IRP 2010 – 2030, which stipulates that nuclear power will form part of the country's energy mix to a level of 9 600 MW.

The nuclear vendor parade workshops entail vendor countries presenting their nuclear technology offerings.

The NDP enjoins DoE to do thorough investigations on various aspects of the nuclear power generation programme before a procurement decision is taken. The vendor parade workshops form part of the Government's technical investigation in preparation for a procurement decision.

South Africa already held one workshop in October 2014 with Russia.

The platform is created for vendor countries to showcase and demonstrate their capabilities on how, if chosen, they plan to meet South Africa's needs.

Government remains committed to ensure energy security for the country, through the roll-out of the nuclear new build programme as an integral part of the energy mix. Government remains committed to ensuring the provision of reliable and sustainable electricity supply, as part of mitigating the risk of carbon emissions.

The nuclear new build programme will enable the country to create jobs, develop skills, create industries, and catapult the country into a knowledge economy.

Proper safety measures were put in place and overseen by the appropriate expert authorities. As a member of the IAEA, 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 of 1999. The DoE administers these Acts.

The Department of Health (DoH) administers the Hazardous Substances Act, 1973 (Act 15 of 1973), related to Group 3 and Group 4 hazardous substances.

Skills development strategies and acquisition and retention of the relevant skills to support the nuclear programme are addressed in the following categories:

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

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

- securing 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 main organisations directly involved in the nuclear sector fulfil the following functions:

- The DoH'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 is responsible for about 6% of total electricity generation and is owned by Eskom.
- The iThemba Laboratory for Accelerator-Based Sciences brings together scientists working in the physical, medical and biological sciences. The facilities provide opportunities for modern research, advanced education, the treatment of cancers and the production of unique radioisotopes.
- The nuclear fuels corporation of South Africa is responsible for uranium-ore refinement and export.

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.

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.

Following the Fukushima nuclear accident, South Africa, through the NNR, needed to find assurance in terms of the safety of existing installations. The safety of the Safari-1 research reactor and Koeberg nuclear power station were reassessed.

In September 2013, the DoE launched the public-consultation phase for the formulation of an Integrated Energy Plan (IEP) for South Africa, which it says should be published during the course of 2014.

The publication of an IEP is a requirement of the National Energy Act of 2008, but South Africa has hitherto not had a fully consulted IEP as envisaged in the legislation, despite having published an Integrated Resource Plan for electricity early in 2011.

Renewable Energy Independent Power Producer Procurement (REIPPP) Bidding Programme

This programme is an indication that government wants to create space for IPPs to also generate electricity in the country. By 2014, under the REIPPP the department was expected to enter Window 3 having already selected bidders for a total of 2 614 MW to be added to the country's power grid by 2016.

South Africa wants to procure 3 625 MW of renewable energy through this process.

According to the IRP 2010, about 42% of electricity generated in South Africa has to come from renewable resources.

Job opportunities, local content and community development are the essential ingredients of the programme.

Localisation needs constant emphasis because in its design and implementation, the REIPPP is biased toward the economic development of the country with bidders being subjected to local content assessment.

Integrated National Electrification Programme (Inep)

Inep is an initiative of government to provide capital subsidies to municipalities to address the electrification backlog of permanently occupied residential dwellings.

The purpose of the Inep is to manage the electrification planning, funding and implementation process with the aim of addressing electrification backlog and to reach universal access by 2014.

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 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.

By November 2014, steady progress was being made with regards to the construction of

the Medupi coal fired power station in Limpopo, to deliver Unit 6 within the December deadline.

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.

By October 2014, work was progressing well at Eskom's Kusile power station, with the barring gear motor at Unit 1 of the power station being switched.

Kusile, which is being built near Emalahleni in Mpumalanga, is a six-unit coal fired power station that will generate approximately 4 800 MW of electricity.

The power station's unit six is set to see first power to the grid in the second half of 2015.

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.

Designated National Authority (DNA) for Clean Development Mechanism

The DoE 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 the 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.

Liquid Fuels Roadmap

As a result of identified constraints throughout the liquid-fuels supply chain, the DoE embarked on a process 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.

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 has awarded technology group Siemens the contract to supply 46 wind turbines to its 100 MW Sere wind farm project being developed on a 3 700-ha site near Vredendal in the Western Cape. The R2,4-billion renewable-energy project was scheduled to begin feeding electricity into the grid by the first half of 2014.

The turbine contract comprises about 65% of the project's total capital expenditure, with the other main contract being for the supply, installation and commissioning of a 132-kV transmission line and a substation close to the project site.

Sere is receiving some of its funding from the World Bank's US\$3,75-billion Eskom Investment Support Project, approved in 2010 primarily to support the Medupi coal-fired power station. Additional funding was secured from the African Development Bank (AfDB), the French development agency, Agence Française de Développement (AFD), and the Clean Technology Fund.

In total, the World Bank component comprises 32,4% of the overall funding plan for Sere, situated about 300 km north of Cape Town. The AFD component, meanwhile, is 36,7%, while the AfDB component comprises 26,8%. Eskom is carrying the development costs.

Each turbine has a height of 115 m, a rotor diameter of 108 m and a power output of 2,3 MW.

The turbine order was the second for Siemens in South Africa, with the first having been awarded by the developers of the 138-MW Jeffreys Bay wind farm.

The Eastern Cape wind project secured a power purchase agreement following the first bidding round under South Africa's Renewable Energy Independent Power Producer Procurement Programme.

Mainstream Renewable Power, Globeleq, Thebe Investments, Enzani and Usizo constructed the project.

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.

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

At bilateral level, the DoE signed seven agreements/declarations of intent with Denmark, the DRC, Ghana, the International Energy Agency, Korea, Lesotho and the Swiss Confederation. These agreements cover access to capacity-building, funding, technology, exchange of information and the development of energy infrastructure on the continent, with the objective of increasing generation capacity.

The Royal Danish Embassy and the GEF through the South African Wind Energy Project financially supports the WASA.

In August 2014, Cabinet approved the ratification of the treaty on the Grand Inga hydropower project between South Africa and DRC, paving the way for the next phase of what could eventually become the largest hydroelectric project in the world, with the potential to power half the continent.

The Grand Inga project will seek to harness the power potential of the Congo River, sub-Saharan Africa's greatest waterway. Once all seven of its planned phases are complete, it is expected to generate a massive 40 000 megawatts (MW) of renewable power.

Two existing dams, Inga 1 and 2, have been in operation since 1972 and 1982 respectively, together generating nearly 1 800 MW. The next phase of the Grand Inga project, Inga 3, is expected to cost in the region of US\$12 billion and produce around 4 800 MW of electricity. Subsequent phases, adding up to an eventual total capacity of 40 000 MW, will allow countries in southern Africa, north-east Africa and parts of west Africa to benefit from production at the site.

The ratification of the treaty paves the way for the development of Inga 3, which will provide 2 500 MW of electricity to South Africa and contribute to regional integration, energy security and economic growth in an environmentally sustainable manner.

The project has the potential to supply clean and affordable imported hydroelectric power to meet the needs of the DRC, South Africa and surrounding countries.

The project holds the potential to fast-track SADC development, alleviate energy poverty, stimulate economic growth and facilitate infrastructure development. This represents one of the most ambitious projects ever undertaken on the African continent, and one, which will long be a resounding symbol of the rise of Africa and her people.

In June 2014, South Africa celebrated the success of REIPPP in a landmark deal that saw the country sell off excess energy to neighbouring African countries.

According to the South African Excess Energy Export Committee (SAEEEC), which tendered the energy sales deal, the country has been growing in terms of its high level of renewable energy potential – and has recently surpassed the mark needed to safeguard local energy needs. In particular, solar and thermal initiatives helped to drive the success of the REIPPP to that which it is today.

There are 30 wind farms in operation, with many more under construction. Therefore, government decided to sell off this excess energy to South Africa's neighbouring countries including Mozambique, Namibia, and Zimbabwe. It is the dawning of a new era of sustainability and growth not just for South Africa, but also for the African continent as a whole, with South Africa leading the way with regard to unlocking possibilities.

The Mozambique Energy Reception Commission also expressed their excitement at being part of this unprecedented undertaking.

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 CO₂ 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.