South Africa's Nuclear New Build Programme

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The South African Nuclear Energy Corporation (Necsa)







Necsa's Main Functions (Nuclear Energy Act, 1999)



 To undertake and promote research and development in the field of nuclear energy and radiation sciences and technology and to make these generally available.

Drive the full value chain from research to products

- To process source material, special nuclear material and restricted material and to reprocess and enrich source material and nuclear material.
- To co-operate with any person or institution in matters falling within these functions. Competitive, relevant, benchmarked, recognised

Execute institutional responsibilities on behalf of government, e.g. operation and utilisation of SAFARI-1, decommissioning and waste management, international obligations.

Responsible, safe, efficient and conforming





Some services offered by Necsa



- Measurement of radioactivity
- Radiation and reactor calculations
- Non-invasive plant investigations
- Non-destructive testing
- Decommissioning, decontamination and site clean-up
- Radioactive waste management
- Nuclear safeguards
- Radiation protection services
- Calibration and analytical services
- Nuclear manufacturing

Necsa Strategic Focus Areas and Pockets of Excellence



NTP Radioisotopes SOC Ltd



Technicium-99 42 Mo 99 (65.976 h) 1.357-0.921 β⁻ 1.214 MeV 82.2% γ 740 keV 12.3% γ 778 keV gamma camera 4.30% 0.181-43 Tc 99m (6.007 h) $\alpha_{\rm T} 1.37 \cdot 10^{10}$ 0.141 0.141γ 181 keV ly 141 keV 6.14% 89% 0.0 0.0 43 Tc 99 (2.1.10⁵ a) Ion exchange resin Holds Mo-ion strongly Holds Tc-ion weakly NovaTeeP Radiochemistry Tc-radiopharmaceutical Тс NE A

Mo-99 production at NTP



Pelchem SOC Ltd

- Manufacturer and supplier of speciality and commodity fluorochemical products (25 products to 27 countries on six continents)
- Operates, maintains and grows a portfolio of fluorochemical businesses, and play a leading role in the Fluorochemical Expansion Initiative (FEI)
- Preserve HF and Fluorine technologies for a future SA nuclear program



Pelchem Process Flow



SA's Nuclear Energy Policy (2008)







Nuclear Energy Policy



- South Africa's vision for nuclear power is based on the Nuclear Energy Policy of 2008 Some of the key government objectives for the nuclear new build programme include:
 - Promotion of nuclear energy as an important electricity supply option through the establishment of a national industrial capability for the design, manufacture and construction of nuclear energy systems;
 - Contribution to the country's national programme of social and economic transformation, growth and development;
 - Improvement of the quality of human life and to support the advancement of science and technology
 - Attainment of global leadership and self-sufficiency in the nuclear energy sector in the long term;



Uranium: Necsa shall participate in the uranium value chain, beneficiation thereof and will be responsible for storing of uranium supplies acquired by the State

Conversion: Government, through Necsa, shall undertake and lead the development of uranium conversion capabilities as part of the beneficiation of uranium. Private sector participation in the conversion process will be promoted

Enrichment: Government, through Necsa, shall investigate the viability of developing its own uranium enrichment capabilities and will simultaneously actively seek to obtain access to established uranium enrichment programmes to ensure security of supply

Fuel Fabrication: Government, through Necsa shall design a strategy to develop nuclear fuel fabrication capabilities. Government will in the intervening period actively seek to obtain access to established fuel fabrication programmes to ensure security of supply

Necsa's roles in the Nuclear Energy Policy (NEP) 2008



- Necsa will contribute to the localisation of the nuclear build programme.
- We are the only company on the African continent with an ASME III certification allowing for the production of critical nuclear components.
- Through our existing training programmes we produce hundreds of artisans and technicians who are deployed in important sectors of our economy such as the automotive and mining industries.
- Necsa's pronouncements on energy are aimed at revitalizing the South African economy. The expansion of nuclear energy should be seen as a part of the broader process of industrialization in South Africa.

SA's IRP 2010-2030







Integrated Resource Plan 2010-2030



The South African IRP2010 plan envisages a 23% nuclear compliment of the new electricity generation capacity by 2030.

Many developed parts of the globe are already powered by more than 400 nuclear power plants.

Picture taken by NASA's Defence Meteorological Satellite Program (DMSP)



Deployment of different energy sources





SA Imperatives For Nuclear







SA imperatives for nuclear



South Africa faces energy constraints and therefore needs:

- A stable supply of electricity.
- A reliable energy supply for the economy to remain competitive
- To renew its ageing energy infrastructure to power the development agenda
- Access to modern energy services as the key to poverty eradication.
- A reduction of carbon emissions by 34% by 2020 and 42% by 2025. This calls for cleaner energy generation technologies.
- All available sources of energy to increase diversity and resilience in energy supply.

Proposed Nuclear Energy Programme for South Africa









- Procuring a fleet of nuclear power reactors with a total electricity generation capacity of 9,600MW.
- Procuring a multi-purpose research reactor (MPR) as a replacement for the SAFARI-1 research reactor at Necsa.
- Developing a policy framework that will enable beneficiation of locally available mineral resources that will serve as inputs into the NNB Programme.
- Procuring nuclear fuel cycle technology to provide locally produced nuclear fuel for the lifetime of the reactor fleet.



- Procuring the relevant skills and capacity, where required, to execute construction of all of the above in South Africa.
- Establishing, developing and sustaining a dedicated skills development programme for SA's nuclear sector.
- Leveraging Necsa's ASME III and ASME VIII certification for the design and manufacture of nuclear components and equipment so that local content can be realised progressively over the life of the NNB Programme.
- Funding and financing models are being evaluated by Government.



- Implementing a Supplier Development Programme to ensure that a South African value chain is established, benefits local content inputs into the NNB Programme, and is sustained over the lifetime of our nuclear power plants.
- The South African New build programme is estimated at over R400 billion for the installation of 9.6 GW by 2030. Several funding models are currently being analysed. The R1 trillion figure, often repeated in the media, is totally unfounded. By international comparison it is not conceivable that South Africa's nuclear new build programme could cost a trillion Rands.

South Africa's Nuclear Experience







South Africa is an old nuclear energy country





South Africa as a nuclear energy country



- Over the past 32 years, Koeberg Power Plant has been generating base-load electricity to the Western Cape with impressive efficiency, safety and reliability.
- The SAFARI-1 Research Reactor celebrated 50 years of its safe operation on 18 March 2015. The facility provides the world with scientific solutions and saves millions of lives every year through its nuclear medicine production capability.
- Both SAFARI-1 and Koeberg have proven to the international community that South Africa has the capacity to operate, maintain and refurbish nuclear installations of this sophistication.

Nuclear Fuel Cycle Materials Beneficiation and Management

The NFC and Materials Beneficiation



LLW and ILW Disposal at Vaalputs



Nuclear Waste Science and Technology



HLW repository development support

Research to best recover valuable EU from Mo waste stream





NMC: Preparation for Localisation (NPP)

Not all areas of localisation can be established in short term.

Manufacturing provides a good way in.

Phased approach to build skills and comply with quality requirements

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- Enable localisation from first unit
- Has learning curve impact (time and cost)



Localisation through manufacturing-continued

Necsa's approach to localisation:

• Localisation of identified products for new build programme

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- Nuclear fuel, vessels, piping and components
- Servicing maintenance requirements of NPP
- Global registered supplier of above identified components
- Joint Ventures and Partnerships
- Only on commercial basis

NMC Certifications

Certification held at present;

- ISO 9001
- ISO 3834
- OHSAS 18001
- ASME VIII U Stamp
- ASME III N Stamp Holder
 - NPT Class 1, 2, 3 CS & MC Components
 - NS Class 1, 2, 3 & MC Supports
 - NA Class 1, 2 & 3 Shop Assembly





Nuclear Skills Development Centre

Technical skills training on Necsa site



Performance Areas



Progress on South Africa's Nuclear Build Programme







Background to SA Nuclear Programme





Background to SA Nuclear Programme (cont.)



2013	 Completion of the Integrated Nuclear Infrastructure Review Mission Department of Energy designated as Procuring Agency 	
2014	 Completion of the Emergency Preparedness Review Mission Launching of the National Radioactive Waste Disposal Institute SONA - Nuclear Energy to form more than 9GW of electricity mix 	
2014	 Signing of Inter-Governmental Agreements with Russian Federation, France and People's Republic of China. (USA and South Korea signed in the past and Japan still pending) 	
2014	 Vendor Parades conducted with Russian Federation, France, People's Republic of China, USA and South Korea. 	
2015	 Vendor Parades conducted with Japan and Canada – completion of pre-procurement Commence Procurement Process-Second Qtr. Finalise procurement select Strategic Partner or Partners- End of year 2015 	
2016	 Cabinet on 2 November decided that the Nuclear New Build programme would be spearheaded by a joint procurement team consisting of Eskom and Necsa Eskom will be the Owner Operator for the nuclear power plant construction Necsa will be Owner Operator for the nuclear fuel cycle and the new Multi-Purpose Reactor Joint ESKOM/Necsa RFI issued 20 December 2016 	

SA Inter-Governmental Agreements with Vendor countries







Intergovernmental Agreements (IGAs)



- Intergovernmental Agreements (IGA's) have been signed with vendor countries that have shown interest to participate in the nuclear build programme.
- To date South Africa signed with China, France, Russia, USA and South Korea.
- IGA presented in Cabinet for discussion and tabled in Parliament for ratification
- These IGA's lay foundation for cooperation, trade and exchange of nuclear technology as well as procurement.
- The IGA's also describe broad areas of nuclear cooperation and they differ on emphasis based on unique needs, interest and capacity of each country to cooperate with South Africa.
- Describe rules of engagement for South Africa with each vendor country

Intergovernmental Agreements (IGAs) (cont.)



- Areas of Cooperation cover entire Nuclear New Build Programme:
 - Nuclear Power Plant Technology and Construction,
 - Multipurpose Research Reactor Technology and Construction;
 - Financing and Commercial Matters;
 - Manufacturing, Industrialization and Localization;
 - Human Resources and Skills Development;
 - Public Awareness and Information Centers;
 - Safety, Liability and Licensing;
 - Nuclear Fuel Cycle (Front and back end);
 - Nuclear Siting and Permitting;
 - Nuclear Non-proliferation Matters

Localisation









An independent report titled "South Africa: The Economics of Nuclear Energy" was prepared by Trusted Sources (TS - UK), a UK based research and consulting company, in March 2016. Main findings relating to localisation were:

- Developing nuclear energy for the first time or, as would be South Africa's case, expanding materially on a small existing base of capacity and scientific and technical skills is the positive shock to industry and the skills base that can come from the localization of a part of the investment in nuclear new builds.
- The extent of potential localization varies according to the choice of main vendor and technology. We have modelled the impact on overall economic growth of two levels of localization relative to a scenario of "no localization" (that is, no nuclear energy development). The base level is 15 per cent localization, and the high case is 45 per cent, based on indications of maximum possible localization levels indicated by some potential vendors including the French and the Russians.



The following table presents the parameters used to model the two localization scenarios:

Scenarios	Scenario A	Scenario B
Localization	15 per cent	45 per cent
Invested in local economy	15 per cent*\$50bn = \$7.5bn	45 per cent*50bn = \$22.5bn
Invested in the first 5 years	30 per cent*\$7.5bn = \$2.25bn	30 per cent*\$22.5bn = \$6.75bn
Investment for the rest of the project	\$7.5bn-\$2.25bn = \$5.25bn	\$32.5bn-\$9.75bn = \$15.75bn



There is a clear reaction of GDP to localized investment and its effect of increasing industrial activity.

Under the highest level of localization (Scenario B) the model indicates that the average annual GDP growth rate would be 0.007 per cent higher than in the no localization scenario, while the equivalent figure in the 15 per cent localization scenario (Scenario A) would be 0.002 per cent.

While these gains are clearly marginal, they are not negligible given that the largest incremental input is only 45 per cent of US\$50 billion spread out over 22 years, where every year GDP is over US\$300 billion.



Another perspective on the scale of this contribution can be gained by aggregating the monetary value in current USD of the incremental GDP attributable to the 45 per cent localization of investment in NPP development.

That number is USD77.3 billion (compared to US\$26 billion in the 15 per cent localization scenario) – or around one quarter of South Africa's current annual GDP. This compares with the USD22.5 billion of "localized" investment in domestic industry: there is thus a substantial multiplier effect that, according to the model, would be around 3.4x.

International Nuclear Industry Study Tours









South African nuclear industry delegations undertook study tours to several international vendor countries, including:

- France;
- South Korea;
- Japan; and
- Russia





 Following the international vendor study tours, an assessment was undertaken to ascertain South Africa's industrial capability









Current Status



Following a Cabinet meeting of 1 and 2 November 2016, the following decisions were made:

- Cabinet designated Eskom as the Owner Operator and Procurer for Nuclear Power Plants in accordance with the Nuclear Energy Policy of 2008;
- Cabinet also approved designating the South African Nuclear Energy Corporation (Necsa) as the Owner Operator and Procurer for Nuclear Fuel Cycle and Multi-Purpose Reactor; and
- The Department of Energy will continue to act on its mandate as the policy setting and coordinating department of the Nuclear Build Programme.
- A joint ESKOM/Necsa RFI was issued on 20 December 2016 (closing end-April 2017).
- A formal RFP will then be issued.

Expectations of Japan







Expectations of Japan



- SA's nuclear new build programme procurement initiated
- Next phase will be RFP issuing
- This will be followed by negotiations and contracting
- At this point vendor requirements will be defined and agreed
- At this stage South Africa is seeking partnerships around nuclear skills development





