



Science and technology



**SOUTH
AFRICA**
YEARBOOK
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The science and technology (S&T) sector in South Africa is filled with examples of competence and excellence, and has immense potential to support South Africa in contributing to improving the country's development status, expanding economic growth and enhancing quality of life for many communities.

The aim of the Department of Science and Technology is to realise the full potential of S&T in the social and economic development of human resources (HR), research and innovation.

The department funds basic research at universities and public entities, including science councils, so that they can train scientists, engineers and technologists and produce publications and patents. Almost 60% of the department's R4,4 billion budget is spent on public entities. Of the overall research and development (R&D) spend, the greatest portion is on the natural, medical and health sciences.

Entrepreneurship and private-sector innovation are encouraged through an annual R200-million R&D tax incentive.

Some of the work being supported by the department includes its operation in a wide range of fields, from aerospace to palaeoanthropology; stem-cell research to nanotechnology; reviving African identity to understand social change; and advancing excellence in health and agriculture.

The focus for 2010/11 was to address the innovation chasm by establishing the National Intellectual Property Management Office (NIPMO) as a government agency. By June 2011, an administrative NIPMO was established. Work is in progress towards establishing NIPMO as a stand-alone government component, which is a major step in stimulating innovation and economic growth for the country. The objective is to ensure that intellectual property (IP) created from publicly financed R&D is identified, protected and used for socio-economic benefits as well as IP management training.

Since the announcement of South Africa and Australia as potential candidates for the core of the Square Kilometre Array (SKA) radio telescope, a number of initiatives have been undertaken to demonstrate the country's readiness.

To this end, South Africa has created a radio astronomy reserve in the Karoo, near the small town of Carnarvon in the Northern Cape.

The commissioning of the Karoo Array Telescope (KAT-7) was expected to be completed by

the end of 2011. KAT-7 is a test bed for the Karoo Array Telescope known as the MeerKAT radio telescope array, which will start operations in 2016.

The MeerKAT passed its concept design review in July 2010. This was a major milestone in the construction of the 64-dish radio telescope in the Karoo Astronomy Reserve.

With 64 offset dishes, each 13,5 m in diameter, the MeerKAT will be one of the largest, most sensitive and scientifically most exciting radio telescopes in the world. It has attracted international interest from scientists, engineers and industry. MeerKAT is a true test for SKA engineering, as it encapsulates the dish-design specifications of the SKA antennae.

The Karoo Core Astronomy Advantage Area will contain the MeerKAT radio telescope and some of the core planned SKA radio telescopes that will be used for the purposes of radio astronomy and related scientific endeavours.

By July 2011, five years before the MeerKAT goes online, 43 000 hours of observing time, including a consortium led by internationally renowned astronomers, had been allocated for astronomy.

In November 2011, the Department of Science and Technology launched its *Full Moon Fever* Campaign to support the SKA bid with a play titled *African Stars* at the State Theatre in Pretoria.

The *Full Moon Fever* Campaign included events scheduled for the Friday or Saturday closest to the full moon of each month; S&T career exhibitions organised by the Tshwane University of Technology and the University of South Africa; and a nine-province tour of the *African Stars* production. South Africans were also urged to place messages of support for the bid on the SKA website.

It was announced in May 2012 that the SKA would be hosted by South Africa and Australia.

Legislation

Parliament has approved several laws, including the Intellectual Property Rights from Publicly Financed Research and Development (IPR) Act, 2008 (Act 51 of 2008), and the South African National Space Agency (Sansa) Act, 2008 (Act 36 of 2008).

The Sansa Act, 2008 provides for the establishment of a national space agency, in line with the space S&T challenge, while the IPR Act, 2008 promotes the protection and commercialisation

South Africa has the third-largest biodiversity resource base in the world. Several biopiracy cases involving the pelargonium, rooibos and honey bush biological resources have recently been lodged with the European Patent Office. The Department of Science and Technology is supporting the Department of Trade and Industry in its initiative to amend intellectual property laws to broaden the protection that indigenous knowledge enjoys.

of IP derived from publicly financed R&D for the benefit of all South Africans.

It establishes the NIPMO and provides for the setting up of offices of technology transfer at institutions.

Policy framework

The Department of Science and Technology's 2002 National Research and Development Strategy (NRDS) and its 10-Year Innovation Plan of 2007 remain the basis for its interventions.

It continues to invest in, promote and catalyse innovation in South Africa according to national priorities, namely global change, renewable energy, space science, the bio-economy and human sciences.

By June 2011, the department had finalised the 10-Year Global Research Plan to guide research aimed at a better understanding of global environmental changes to provide a scientific basis for responses to climate change.

Ten-Year Innovation Plan

Since 2008, the Department of Science and Technology has focused primarily on implementing the 10-Year Innovation Plan, while continuing with the implementation of the NRDS.

The aim of the plan is to assist in establishing a knowledge-based economy for South Africa, in which the production and dissemination of knowledge lead to economic benefits and enrich all fields of human endeavour.

Its success will be measured by the extent to which S&T contributes towards enhancing productivity, economic growth and socio-economic development.

The department has five strategic goals, namely to:

- develop the innovation capacity of the science system and thereby contribute to socio-economic development
- develop South Africa's knowledge-generation capacity

- develop appropriate human capital for research, development and innovation (RDI)
- build world-class RDI infrastructure
- position South Africa as a strategic international RDI partner and destination.

Expenditure on research and development

Over the past decade, R&D expenditure has grown fivefold from R4 billion to R21 billion. By 2011, there were 14 000 scientists, engineers, technologists, technicians, managers and other technical staff directly involved in R&D.

South African universities train more and more scientists each year, and by 2011 some 30% of science PhD students came from the rest of Africa. The Department of Science and Technology aims to spend R45 billion on R&D by 2014 to reach its target for gross expenditure on R&D of 1,5% of gross domestic product (GDP).

The department has strengthened its interaction with business leaders of companies that invest heavily in S&T, regarding programmes and the policies that impact on them, particularly the Research and Development Tax Incentive Programme. The tax incentive has been available since 2008, and between 2008 and 2011, companies have claimed R632 million back from the South African Revenue Service under the incentive.

Human-capital development

The Department of Science and Technology's Human Capital and Science Platforms Subprogramme conceptualises, formulates and implements programmes aimed at the development and renewal of science, engineering and technology (SET) human capital to promote knowledge generation, protection and exploitation.

The subprogramme also develops science platforms that leverage South Africa's geographical advantages; and promotes SET, Mathematics, and innovation literacy and awareness.

By July 2011, the South African Square Kilometre Array Project Office had awarded almost 300 grants and scholarships worth about €15 million to students and scientists from several African countries. Some of this aid has been instrumental in helping to establish new radio astronomy and related undergraduate courses at universities in Botswana, Ghana, Kenya, Madagascar, Mauritius, Mozambique and Zambia.

Early in 2011, about 272 interns graduated from the Department of Science and Technology and the National Research Foundation (NRF) Internship Programme.

Since 2006, almost 750 interns have been hosted by various Department of Science and Technology institutions, including science councils, national facilities and museums. By 2011, R29 million had been invested in the programme, with a further R45 million earmarked for the next three years.

The initiative has proven valuable in increasing the HR science pool. In addition, 60% of interns have been absorbed as permanent employees by their host institutions.

At the sixth Science Centre World Congress in Cape Town in September 2011, the Minister of Science and Technology, Ms Naledi Pandor, announced the establishment of 26 science centres across South Africa. The centres are seen as vital to developing human capital and strengthening the country's S&T culture.

In October 2011, the Deputy Minister of Science and Technology, Mr Derek Hanekom, opened the first science centre in Mothibstad in the Northern Cape. Science centres aim to enhance S&T literacy among the youth and the public and to nurture youth talent with potential for S&T-based careers.

As part of the initial phase, the department equipped the science centre with interactive exhibits worth about R650 000. The Northern Cape Department of Education provided computers and software for the computer simulations done by the astronomy-awareness programme run by the South African Astronomical Observatory (SAAO). This centre will provide support in the learning and teaching of Mathematics and Science to about 197 schools in the area.

In September 2011, the South African Young Academy of Science (SAYAS) was launched.

The SAYAS is intended to facilitate and enhance the participation of young scientists in the mainstream of R&D across all disciplines and to provide young scientists with the opportunity to use their knowledge to address South Africa's socio-economic challenges.

A number of postdoctoral students receive funding through centres of excellence (CoEs) and the South African Research Chairs Initiative (SARChI), which was established in 2006.

The Department of Science and Technology launched the CoEs Programme in 2004 to support the development and funding of high-quality research of a globally excellent standard and to respond to the education and training of highly qualified individuals in the strategic areas of S&T and medicine. The CoEs are hosted by specific universities, but also draw on expertise from other institutions.

The SARChI is proving to be an effective instrument for developing human capital. The R200-million-a-year initiative supports 82 research-chair professors and 10 others co-funded by the business sector.

Half of the current research chairs works in the natural and agricultural sciences, while the other half works in health sciences, social sciences and humanities, and engineering. Most research chairs are in basic research fields, but there are a few in technology development and innovation. The majority of these research professors work at the country's six research-intensive universities.

By 2014, SARChI will be a R428 million-a-year initiative supporting 154 research chair professors. An extra 25 postdoctoral fellowships, each worth R180 000 a year for three years, will be created.

International science cooperation can be seen in the growth of the number of internally co-authored publications, particularly after 2004, and of citations, according to *Science Watch*. Papers co-authored with the United States of America (USA) rose from 1 700 to nearly 5 000 between 1994 and 2008. South Africa is strong in several fields, including computer science, environment/ecology, space science, immunology and clinical medicine.

Indigenous knowledge systems (IKS)

The indigenous knowledge of many communities embodies a deeply spiritualised and ancient relationship with the Earth's systems and cycles.

The Centurion Aerospace Village (CAV) was launched in November 2011. It is an initiative by the Department of Trade and Industry to develop a high-tech and advanced manufacturing aero-mechanical and defence cluster adjacent to the Waterkloof Air Force Base in Centurion.

While its primary aim is to integrate local aerospace and defence companies into the global supply chains to become suppliers of choice to original equipment manufacturers such as Boeing, Airbus and Spirit Aviation, the CAV will also be home to new process technologies within the aerospace sector.

In October 2011, the third International Conference on Science and Indigenous Knowledge Systems (IKS) was hosted by the School of Science and Mathematics and Institute of Public Administration of the University of the Western Cape.

The introduction of the Bachelor of IKS Degree at universities will produce unique knowledge and the human capital required to sustain the country's National System of Innovation.

Traditional songs and languages, clothing, architecture, foods, motifs, daily rituals and mythological epics contain local survival information. Moreover, the diversity of indigenous cultures provides unique insights into how to live harmoniously within nature.

By sharing indigenous stories of vulnerability and adaptation, people learn how communities share ideas on how ancestral wisdom is being incorporated into climatic adaptation strategies. By cherishing the value of indigenous knowledge, people can discover how best to adapt to a changing climate.

The San and Khoi, the earliest people to live in South Africa, were among the first to record and document their struggles against the challenges of climate change through rock art that dates back almost 80 000 years.

Indigenous communities all over the world have used their local knowledge to interact with the environment.

The Department of Science and Technology has three IKS priorities. The first of these is the development of a regulatory environment for the protection of IKS.

The second is the development of the National Recordal System for the collection, recording, documenting, storage, management and dissemination of IKS in communities in the nine provinces of the country. Until verbally transmitted and rapidly disappearing indigenous knowledge is recorded, it will be difficult to protect.

The National Recordal System is the largest fingerprint initiative of the region to document and record indigenous knowledge. This system aims to collect successful grassroots community knowledge and experiences, which will prove to be a valuable resource in improving the understanding of how communities empower themselves to manage their own development.

In addition to the establishment of IKS documentation centres in KwaZulu-Natal and Limpopo, an IKS documentation centre was also expected

to be established in the Moruleng area in North West by the end of 2011/12. The department aims to establish IKS documentation centres in all the provinces by 2013.

The third strategic priority is applied research, specifically bio-prospecting activities. An example would be how, with funding from the NRF, the Medical Research Council (MRC) is developing the Moritela Tshwene Tea Project near Zeerust in the North West, with the aim of producing a nutritional herbal tea for the commercial market.

The Department of Science and Technology has put in place validation systems within its science system to ensure that indigenous knowledge products are safe and backed by the best science in the world. To give further impetus to these critical initiatives, the department has set aside a dedicated fund to support research into indigenous knowledge.

The fund is open to all South African researchers, whether they are based in higher institutions of learning or in communities. In addition to funded research, the department has a vision of growing a new generation of researchers in the field of indigenous knowledge.

Two indigenous knowledge research chairs have been awarded as part of the SARChi. The first was awarded to the University of KwaZulu-Natal for work in the field of traditional medicines. The second has been awarded to the Walter Sisulu University. These two chairs represent significant injections into the development of national research capacity in IKS.

The Department of Science and Technology also established an indigenous knowledge studies CoE at the universities.

Science bodies

These include the:

- Technology Innovation Agency (TIA)
- Sansa
- National Advisory Council on Innovation (Naci).

Technology Innovation Agency

TIA was established in terms of the TIA Act, 2008

The Intellectual Property (IP) Laws Amendment Bill was tabled in October 2011. It is the sequel of two policy processes, namely, the development of the Indigenous Knowledge Systems (IKS) Policy adopted in 2004 and the Policy on Protection of Indigenous Knowledge through the IP system in 2007.

(Act 26 of 2008). Its task is to channel the existing body of knowledge at universities and public research institutions towards the development of technology-based industries. TIA was formed after the merger of seven organisations funded by the Department of Science and Technology, including the Advanced Manufacturing Technology Strategy, Biotechnology Partnerships and Development, Cape Biotech Trust, Innovation Fund, EcoBio LIFElab, Tshumisano Trust and Biopad Trust, and is mandated to stimulate and intensify technological innovation to improve economic growth and the quality of life of all South Africans.

The agency is set up to be a world-class innovation organisation that supports and enables technological innovation to achieve socio-economic benefits for South Africa by leveraging strategic partnerships.

The agency seeks to build on the achievements of its forming entities, by continuing to support innovation and product development in the sectors within which it operates.

The 15 technology stations and institutions of advanced tooling located at higher education institutions across the country made significant contributions towards helping TIA fulfil its mandate. They incubated and cultivated many promising ideas, and equipped many innovators (including small, medium and micro-enterprises [SMMEs]) with the skills and expertise to produce and commercialise their products and services.

The Technology Stations Programme assisted 1 791 clients to produce over 323 prototypes, with pilot manufacturing resulting in 619 new and/or improved products and processes ready for commercialisation. TIA helped 647 SMMEs become internationally competitive, and thus able to export their products and services.

The Department of Science and Technology intends to create an institutional and policy framework that advances and sustains a coordinated and responsive National System of Innovation (NSI). TIA is the key agency in this regard.

By June 2011, about 26 investments had been identified; 11 had a very strong likelihood of enhancing job creation and socio-economic development; 11 others had proceeded beyond proof of concept stage; and four were ready for commercialisation.

In 2011, R433 million was allocated to TIA.

National Advisory Council on Innovation

The Naci Act, 1997 (Act 55 of 1997), mandates the council to advise the Minister of Science and Technology, through Cabinet, on the role and contribution of innovation (including S&T) to promote and achieve national objectives.

The advice should be directed at, among other things:

- coordinating and stimulating the NSI
- promoting cooperation within the NSI
- structuring, governing and coordinating the S&T system
- revising the innovation policy
- promoting strategies of all aspects of technological innovation
- identifying R&D priorities
- funding the S&T system.

In November 2011, the Department of Science and Technology; the Human Sciences Research Council's (HSRC) Centre for Science, Technology and Innovation Indicators; and the Naci hosted a workshop on measuring and monitoring innovation in South Africa. The purpose was to review the scope and objectives of the *South African Innovation Survey* and to evaluate other indicators that need to be monitored to better inform policy-making in this area.

The workshop also facilitated:

- learning from international practices and informing the methodology and approach for the innovation survey
- reviewing the lessons learnt from the *South African Innovation Survey*
- evaluating international practices for measurement and monitoring of innovation performance
- reviewing the interface between innovation measurement and policy-making in South Africa
- strengthening the national capacity for data-collection indicator monitoring.

South African National Space Agency

Sansa is mandated by the Sansa Act, 2008 to promote the peaceful use of space, foster international cooperation in space-related activities and create an environment conducive to industrial development in space technology through research, human-capital development, outreach programmes and infrastructure development.

In August 2011, the Nelson Mandela Metropolitan University announced senior Zoology lecturer Dr Kwezi Mzilikazi's selection as an honorary ambassador scientist for the Alexander von Humboldt Foundation.

Dr Mzilikazi is recognised as Africa's first black evolutionary physiologist due to her ground-breaking research into how small mammals cope with challenges posed by their environment.

The establishment of Sansa resulted in the merger and amalgamation of the Council for Scientific and Industrial Research (CSIR) Satellite Applications Centre and the NRF's Hermanus Magnetic Observatory. By March 2011, all the requirements for the migration had been fulfilled, including transfer agreements with the CSIR and NRF, providing for the official establishment of Sansa on 1 April 2011.

South Africa's approach to space S&T is shaped by the National Space Strategy, which has three core objectives:

- capturing a share of the global market for small to medium-sized space systems with the intention of expanding investment in "micro" satellites, building on the existing SumbandilaSAT platform
- improving decision-making through the integration of space-based systems with ground-based systems for providing data
- developing applications for the provision of geospatial, telecommunications, timing, and positioning products and services.

In 2011/12, R93 million was allocated to Sansa. It was directed to assist the Department of Science and Technology in ensuring the provision of support to Sunspace in an effort to convert it into a viable satellite-manufacturing company.

The SumbandilaSAT satellite was designed and built in South Africa for the Department of Science and Technology by SunSpace, a company created by Stellenbosch University. SunSpace has secured orders from international clients for satellites and subsystems, and has demonstrated that it can train engineers in other emerging space nations.

In October 2011, Minister Pandor announced plans to build a third satellite as part of an African satellite constellation. The SumbandilaSat was damaged in July 2011.

While SumbandilaSat was a prototype or "pathfinder" satellite, the new satellite will be a fully

operational shuttle costing about R400 million, compared to the R26 million for SumbandilaSat. It will also be used for Earth observation, in line with South Africa's space strategy, which seeks to apply satellite data to improve livelihoods, reduce poverty and manage natural disasters.

In November 2011, Sansa assisted the National Aeronautics and Space Administration (Nasa) of the USA as it launched the Curiosity rover to Mars. Sansa tracked the Atlas V-missile on behalf of Nasa through its Hartebeesthoek station as the spacecraft split from the missile, sending data and video images to Nasa.

Sansa has been involved in supporting 17 missions to the International Space Station.

Research areas Biotechnology

South Africa's research institutions and universities are conducting biotechnology research to increase production of crops suited to local conditions, enhance crop nutritional value and improve preservation and processing methods, resulting in novel and improved food products.

Research is being conducted into understanding the nutritional components of food indigenous to South Africa, with the aim of making those with a high nutritional value available and accessible to most people.

Within the biotechnology space, South African researchers are doing the country proud. This is especially true in the area of tuberculosis (TB) research, where local researchers are working closely with national health institutes in drug discovery and the development of new potential drugs. The work being conducted at the University of Cape Town and at the CoE for Biomedical TB Research at Stellenbosch University and

Africa's involvement in space activities would help address the challenges of telecommunications, energy and food security on the continent, The Minister of Trade and Industry, Dr Rob Davies, said at the opening of the 62nd International Astronautical Congress in Cape Town.

The International Astronautical Federation's prestigious annual congress, themed *African Astronautics in 2011*, attracted thousands of space players from around the globe. It ran from 3 to 7 October 2011 at the Cape Town International Convention Centre.

This was the first time the congress was hosted in Africa. The congress also coincided with World Space Week, an annual global space celebration that took place in 55 countries around the world from 4 to 10 October 2011.

at the National Health Laboratory Services, are world-class.

South Africa is classified as one of the 14 mega biotech countries in the world, and the only one in Africa. These countries have a special responsibility to ensure that the potential impact of genetically modified organisms on human or animal health and on the environment, together with their probable socio-economic impact, are carefully measured, assessed and estimated before they are released, thus ensuring a favourable risk-benefit ratio.

The objective of the Department of Science and Technology, as stated in the National Biotechnology Strategy (NBS), is to establish a sustainable and competitive biotech industry, which will result in the development of safe and beneficial products.

The biotechnology sector is attracting a fast-growing portion of R&D funding. South Africa is also committed to developing biotechnology in Africa.

Other initiatives include the establishment of biotechnology regional innovation centres (Brics), namely the Biopad, Cape Biotech, LIFElab and the Plant Biotechnology Innovation Centre. Brics were created as instruments for implementing the NBS, and cover a wide spectrum of sub-disciplines in biotechnology. These include human and animal health, biopharmaceuticals, industrial bioprocessing, mining biotechnology, bioinformatics and plant biotechnology.

TIA has absorbed the Brics and will significantly expand on the innovation development portfolios.

The Department of Science and Technology has launched the Public Understanding of Biotechnology Programme to ensure a clear and balanced understanding of the scientific principles, related issues and potential of biotechnology, and to stimulate public debate around its applications in society.

Biosafety

The aim is to make South Africa one of the top three emerging economies in the world in terms of the pharmaceutical, nutraceutical, flavour, fragrance and biopesticide industries by 2018.

Biosafety relates to the avoidance of risk to human and animal health, safety and prosperity, and to the environment, when researching, developing and commercialising the products of modern biotechnology.

The vision of Biosafety South Africa is to support innovation in biotechnology by ensuring the development of safe and sustainable biotechnological products. It promotes the biosafety of biotechnological products through the delivery of value-adding services and investment in strategic biosafety research.

Biosafety South Africa has:

- established firm collaborative partnerships with various international role players in biosafety, including the International Centre for Genetic Engineering and Biotechnology, the Biosafety Resource Network of the Donald Danforth Plant Science Centre and the New Partnership for Africa's Development's African Biosafety Network of Expertise
- developed and commissioned a wide range of strategic biosafety research projects and committed more than R5 million over the 2011 to 2013 period to strategic biosafety research
- established new capacity in South Africa for biosafety research by investing in research groups that had not previously undertaken any biosafety research, and funded 11 postgraduate bursaries.

In the delivery of the NBS, the Department of Science and Technology has set up the necessary instruments to drive biotechnology's commercialisation, a series of technology platforms to enable biotechnology development and a range of capacity-development initiatives to ensure there is human capital for the growing sector.

Astronomy

South Africa continues to promote high-technology investment to ensure that local researchers and students are able to participate in international astronomy.

In October 2010, the Department of Science and Technology established the Astronomy Desk to advise the Minister on substantive policy and

BioFISA is a three-year programme that is jointly funded by the Finnish Government and the Department of Science and Technology to build bioscience research capacity in southern Africa.

The programme is managed by the Southern Africa Network for Biosciences, which manages the funded projects in all bioscience nodes in southern Africa. It is also supported by the New Partnership for Africa's Development. The total amount expended in 2010/11 was R15, 3 million.

In May 2011, it was announced that the Department of Science and Technology would support the Stellenbosch Institute for Advanced Study (STIAS) with a grant of R6,526 million over three years.

Established in 2000, STIAS is the only multidisciplinary think tank for advanced study in Africa. The institute also focuses on nurturing and retaining the intellectual leadership of Africa. It attracts leading international scholars and researchers.

Support for STIAS will complement some of the department's other initiatives, such as the Africa Institute for Mathematical Sciences, the African Laser Centre, the Southern African Network for Biosciences and the newly launched African Doctoral Academy.

strategic matters regarding the development of astronomy. The Astronomy Desk submitted its report to the Minister in March 2011. Key among its recommendations was the establishment of a dedicated national astronomy entity whose main function would be to unite all astronomy activities under a single umbrella body.

The Southern African Large Telescope (Salt) was launched in November 2005, in Sutherland in the Northern Cape.

This is a multimillion-rand project involving Germany, Poland, the USA, New Zealand and the United Kingdom. It is the largest single optical telescope in the southern hemisphere.

As a region, southern Africa is already internationally recognised in the area of astronomy. The region has major astronomy facilities that include Salt and the High Energy Stereoscopic System gamma-ray telescope in Namibia.

Economically, the SKA represents the largest science-based capital injection into the African economy by far. The estimated total investment is in the order of €1,5 billion (R15 billion). This investment will result in a number of immediate and long-term socio-economic benefits accruing to the entire continent.

Immediate benefits are in the form of R&D opportunities during the design phase. Scientists from universities across the continent have an opportunity to participate in the design of SKA novel technologies and instrumentation.

The construction phase of the SKA will generate localised direct benefits in the form of jobs, procurement and sourcing of local materials in each of the partner countries. A combination of these benefits will contribute to improvement in the sub-Saharan GDP.

In addition to the immediate or short-term benefits, there are numerous long-term benefits for the general community at large. Because of the scientific nature of the project, the biggest benefit will be the improvement of the skills base and access to top international research facilities and networks which, in turn, will boost output of scientific publications.

The SKA science provides opportunities for the development of new algorithms and underlying Mathematics for manipulating large data sets, new imaging technologies and techniques and new information and communication technology (ICT) skills beyond what is currently available. These are essential skills which may be applied in other productive sectors of the economy.

The Assembly of Heads of State and Government of the African Union (AU) have adopted a declaration expressing the AU's support for Africa's bid to host the SKA with core stations in South Africa and outer stations in Botswana, Ghana, Kenya, Madagascar, Mauritius, Mozambique, Namibia and Zambia.

The African Ministerial Council on Science and Technology recognised the SKA as a flagship project. The whole of the Northern Cape, excluding Sol Plaatje Municipality, has been declared an astronomy advantage area for optical and radio-astronomy purposes in terms of Section Five of the Astronomy Geographic Advantage Act, 2007 (Act 21 of 2007).

Five new research chairs dedicated to the SKA project were created at leading South African universities and filled by international astronomers and cosmologists, with funding for 15 years committed to these.

Some of the SKA's African partners are doing valuable work building new telescopes or converting redundant satellite telecommunications antennae to establish what will be known as Africa's Very Long Baseline Interferometry (VLBI) Network.

VLBI is significant for imaging cosmic radio sources, or for applications in astrometry. It can also be used to precisely map the movements of the Earth's tectonic plates. When used in conjunction with other economically beneficial facilities such as global positioning systems, VLBI networks can improve the accuracy of surveying and mapping in a country.

For this reason, South Africa is assisting Ghana with the construction of a radio telescope using

a communications antenna that was acquired by the Ghanaian Government. The radio telescope is expected to boost postgraduate research and teaching programmes in radio astronomy.

If linked to the MeerKAT as an anchor, the African VLBI Network will provide unparalleled resolution in the southern hemisphere. It will effectively look like a pre-phase I of the SKA, thereby demonstrating the seriousness of Africa's bid to host the SKA.

The 62nd International Astronomical Congress was held in Cape Town in October 2011.

The 34th International School for Young Astronomers was scheduled to take place in February 2012 in Cape Town. It is organised jointly by the International Astronomical Union, the SAAO and the University of Cape Town (UCT).

Nanotechnology

Nanotechnology, unlike other technologies, can find applications in virtually all areas of human life. In spite of it being in its beginning stages, some of the known issues related to nanotechnology suggest a wide spectrum of potential societal impact. For a society to switch from a merely passive, observational role to one of active participation in the public discourse about nanotechnology must be encouraged.

Known as "the technology of the very small" (that is about 1/80 000 of the diameter of a human hair), nanotechnology comprises a wide range of technologies, techniques and multidisciplinary research efforts for application in a range of cross-cutting industries and activities.

These include aerospace, the manufacturing and automotive industries; energy conversion, storage and distribution; the hydrogen economy; chemicals; electronics and information processing; as well as biotechnology and medicines.

The department has stepped up investment in emerging research areas in general and the National Nanotechnology Strategy in particular. Two nanotechnology innovation centres were established at the CSIR and Mintek. The two nano-innovation centres have a budget of R134 million over the Medium Term Expenditure Framework.

In 2011, the department acquired a world-class, R30-million high-resolution transmission electron microscope that was expected to be commissioned in the latter part of the year.

The state-of-the-art electron microscope, one of just 15 in the world and the first in Africa, is

The International Astronomical Union (IAU) global Office of Astronomy for Development (OAD) was launched in March 2011 at the headquarters of the South African Astronomical Observatory.

The OAD is a partnership between the IAU and the South African National Research Foundation to coordinate a wide range of worldwide activities designed to use astronomy as a tool for education and development. This is part of the realisation of a visionary decadal plan by the IAU, entitled *Astronomy for the Developing World*, which aims to use astronomy to stimulate development at all levels including primary, secondary and tertiary education, science research and the public understanding of science, building on the success of the International Year of Astronomy 2009.

housed in the new R120-million Centre for High-Resolution Transmission Electron Microscopy (HRTEM) at Nelson Mandela Metropolitan University in Port Elizabeth.

The Japanese-made instrument is the most powerful high-resolution microscope in Africa, enabling scientists to analyse materials down to atomic level, and making the university a new continental hub for nanoscience research.

The analytical attachments of the instrument make it versatile, with applications ranging across fields as diverse as materials engineering, metallurgy, chemistry, zoology, geology and botany.

The HRTEM was established in collaboration with the NRF; the departments of science and technology and higher education and training; and Sasol.

The National Nanotechnology Strategy focuses on nanotechnology in the area of health as one of its goals. This is the Mintek nanotechnology centre's speciality. It has already developed prototype point-of-care diagnostic tools for diseases such as TB and malaria.

In addition, there are several flagship projects in some of the country's nanotechnology development programmes. In particular, there is the nanotechnology-based TB drug-delivery system, a project led by the CSIR.

The project seeks to address the challenges of the current TB treatment regimen, with the ultimate goal of reducing the frequency and quantity of dosages. This will also reduce the cost of treatment. Through this project, existing TB drugs will be encapsulated into a biodegradable nanopolymer for slow release in the system.

By March 2011, the CSIR and the project team had successfully encapsulated all four first-line TB drugs in nano-polymer using technology they patented. With the project conducting clinical

The Department of Science and Technology sponsors Dinedi learners' participation in the National Science Olympiad through its Youth in Science Programme. It planned an increase in sponsorship from 11 000 learners in 2010 to 20 000 in 2012. Science centres are another important part of the Youth into Science Strategy. A total of 90 schools in Mpumalanga, Limpopo and Gauteng stood to benefit from curriculum-based science experiments provided through mobile laboratories. During 2011/12, the number of mobile laboratories were expected to increase from three to seven.

- engaging the public in all spheres of the field
- recognising the importance of developing a national network of sites to create a vibrant and lasting public engagement with the country's palaeosciences.

Information and communications technology

The Department of Science and Technology is leading the implementation of the national ICT RDI Strategy. Its main purpose is to create an enabling environment for the advancement of ICT RDI in South Africa.

The ICT RDI Strategy aims to achieve a marked increase in advanced HR capacity, promote world-class research and build robust innovation chains for the creation of new high-tech ICT small enterprises. Implementing the strategy demands partnerships involving government, the private sector, Higher Education (HE) institutions and science councils.

The Meraka Institute of the CSIR manages and coordinates the implementation of the strategy. An important envisaged outcome is a vibrant, sustainable and innovative indigenous ICT industry that addresses a significant portion of the country's ICT needs and attracts investments by overseas-based multinational ICT corporations in RDI and manufacturing facilities and resources in South Africa.

The Centre for High-Performance Computing (CHPC), the South African National Research Network (Sanren) and the Very Large Databases are the three pillars of cyberinfrastructure that the Department of Science and Technology supports.

The CHPC in Cape Town was the first of its kind in South Africa. Hosted by the UCT and managed by the CSIR's Meraka Institute, the CHPC is making scientific supercomputing a reality for South Africa.

It supports a diverse base of researchers and scientists, and facilitates the collaboration and multidisciplinary approach needed to solve complex computational problems, advancing South Africa's research capabilities in areas such as advanced manufacturing, space science and research into infectious diseases.

The high-speed computational infrastructure has 50 terabytes of storage space and 160 computer nodes (640 processors) in a clustered architecture. It has a peak performance of around 2,5 teraflops per second.

Sanren, which is responsible for the roll-out of a high-speed broadband network to all academic

trials, prospects for success are looking good. The novelty of the project and its commendable progress saw the team receiving several awards, including a grant from the Bill & Melinda Gates Foundation.

Identification of potential risks associated with nanotechnology and the development of strategies for mitigation should be integral parts of nanotechnology research and development.

As far as safety is concerned, South Africa has embarked on processes for the establishment of a nanotechnology risk-identification-and-mitigation research platform.

The Department of Science and Technology, in partnership with the University of the Western Cape and the Nelson Mandela Metropolitan University, hosted the second nanoscience and nanotechnology summer school in November 2011, targeting Honours and Master's Degree students interested in the nanoscience and nanotechnology fields.

The vision for the school is to create a pool of nanoscientists sufficiently trained to conduct nanoscience research. The theme for 2011 was *Nanoscience Characterisation Techniques*.

Palaeosciences

The South African Strategy for Palaeosciences (incorporating palaeontology, palaeo-anthropology and archaeology) was published for public comment in September 2011. The NRDS describes palaeosciences as a scientific area in which South Africa has a geographic advantage, therefore the strategy provides a holistic framework for the development of this discipline, building on the African Origins Platform.

The strategy addresses five goals centred on:

- building human capital
- providing resource support and an enabling environment to curate and research the country's palaeoscience treasures

In September 2011, the National Research Foundation (NRF) announced the recipients of the NRF President's Awards 2011, which honour the career achievements of rated researchers acknowledged by their peers as world leaders in their fields.

The following researchers received A-ratings:

- Prof. Frank Brombacher: University of Cape Town (UCT)
- Prof. David Glasser: University of the Witwatersrand (Wits)
- Prof. Shabir Madhi: Wits
- Prof. John Pettifor: Wits
- Prof. Lyn Wadley: Wits
- Prof. George Janelidze: UCT
- Prof. Alan Weinberg: University of South Africa.

Other awards included:

- Lifetime Achievement Award: Prof. Malegapuru W Makgoba: University of KwaZulu-Natal
- Transformation of the Science Cohort Award: Prof. Bongani M Mayosi: UCT
- Champions of Transformation Capacity Development at South African Higher Education Institutions Award: Prof. Yusef Waghid: Stellenbosch University.

and research institutions in the country, was awarded a private electronic communications network licence exemption under the Electronic Communications Act, 2005 (Act 36 of 2005).

A major project for Sanren is the national backbone network, which aims to connect all major metros in the country with a 10-gigabyte-per-second link. Phase One of this project was completed in November 2011, linking Salt in Sutherland and the proposed SKA site with Cape Town. On completion, the network will reach about 200 sites, both nationally and internationally. The overall network architecture will consist of a national backbone connecting Durban, Pretoria, Johannesburg, Bloemfontein, Cape Town, Port Elizabeth and East London; with metro rings in Johannesburg, Tshwane, eThekweni and Cape Town.

In August 2011, the CHPC announced it was working with the Cape Universities Brain Imaging Centre on a long-term project that would analyse structural brain changes in subjects suffering from mental diseases such as schizophrenia, obsessive compulsive disorder and bipolar mood disorder.

International science and technology cooperation

In 2011, the Department of Science and Technology grew its portfolio of over 60 international R&D partnerships. One of these is BioFISA, its biotechnology partnership with the Government

of Finland. This national and regional collaboration includes 12 Southern African Development Community (SADC) member states, with a hub at the CSIR.

The department accessed over R300 million in international funding support for South African researchers, leading several important initiatives. It is also liaising with Algeria, Kenya and Nigeria on the African satellite project. South Africa continues its active engagement with the European Union (EU), having established policy dialogue on space science, energy and social sciences, and humanities. This resulted in specific EU Framework Programme calls for proposals aimed at addressing South African and African challenges.

The ongoing dialogue resulting from the AU-EU partnership resulted in the first EU Framework Programme Africa Call, where significant research funds were allocated to S&T research in Africa.

In September 2011, South Africa hosted the International Cooperation National Contact Points Conference, confirming Africa's efforts to collaborate with the rest of the world in using S&T to harness economic development.

National Research Foundation

As an independent government agency, the NRF promotes and supports research in all fields of knowledge. It also conducts research and provides access to national research facilities.

The NRF's three main functions are to:

- support research and innovation, through its agency, Research and Innovation Support and Advancement (Risa)
- encourage an interest in S&T through its business unit, the South African Agency for Science and Technology Advancement (Saasta)
- facilitate high-end research through its national research facilities.

SAP Africa and the Department of Science and Technology announced their support for an advanced human-capital development programme in information and communications technology (ICT) in South Africa in November 2011, by signing a memorandum of understanding.

SAP and the department first joined forces in 2006. Since then, South Africa has seen over R140 million injected into joint ICT research and development activities. The partnership has also given rise to new and exciting innovations within the ICT sector, including the establishment of the SAP-Meraka Unit for Technology Development.

Funding from the NRF is largely directed towards academic research, developing high-level HR and supporting national research facilities. Funding opportunities cover the full spectrum of beneficiaries: from students and researchers through to institutions and staff, and from scientists involved in bilateral and multilateral joint research projects to private individuals or companies and science councils.

Through Risa, the NRF:

- invests in knowledge, people and infrastructure
- develops the workforce, particularly previously disadvantaged men and women, to help all researchers unlock their full creative potential
- facilitates partnerships and knowledge networks
- supports and provides S&T information to guide and steer strategic decisions.

Through Saasta, the NRF:

- steers young minds towards careers in S&T
- interacts with the public on SET issues
- communicates the advances of S&T to the public.

Through the national research facilities, the NRF:

- provides access to unique technologies, research methods and information
- provides state-of-the-art research platforms
- offers access to networking opportunities and international collaboration.

The objectives of the NRF Strategic Plan, NRF Vision 2015, include:

- promoting internationally competitive research as the basis for a knowledge economy
- growing a representative S&T workforce in South Africa
- providing cutting-edge research, technology and innovation platforms
- operating world-class evaluation and grant-making systems
- contributing to a vibrant national innovation system.

The NRF aims to contribute to the knowledge economy in South Africa by attaining at least 1% of global R&D output by 2015. The Department of Science and Technology allocated R1,089 billion to the NRF in 2011/12.

In 2010/11, the NRF's highlights included:

- a fourfold increase in the number of female postgraduate students supported through CoEs
- Risa's grant investment in research equipment at research institutions and national research facilities totalled R186 million

- 599 students, 258 of whom female and 411 of whom black, in Chemistry being supported by contract and core grants
- doctoral students supported by the NRF totalled 1 937
- the first carbon-footprint study for the NRF being undertaken
- a R324-million investment in research areas where South Africa has a geographic advantage
- the completion rate for applications for NRF rating coming to 99,8%
- Risa disbursing a total of R1 billion (81%) in available grant funding
- a 93% increase of post-doctoral students being supported
- a R1,3-billion investment in research grants (including bursaries and scholarships)
- a 37% increase in grant expenditure
- an increase of 28% in total income received
- additional support from the department coming to R255 million to expand bursaries, support for women and young researchers and to upgrade infrastructure.

The National Research Foundation's role in the National System of Innovation

The NRF is a funding agency for research through its Risa division within the NSI, an implementing policy and it is also a research-performing institution mostly through its National Research Facilities division. The foundation is involved in areas such as the following:

- The NRF supports the Department of Science and Technology's Youth into Science Strategy. This strategy promotes S&T literacy among the public in general and the youth in particular. Through Saasta, the NRF supports competitions, camps and olympiads, all of which aim to identify students who have talent and potential

Professor Tebello Nyokong, director of the Nanotechnology Innovation Centre at Rhodes University, received the 2011 Distinguished Women in Chemistry Award from the Royal Society of Chemistry – Europe's largest organisation for advancing the chemical sciences – and the Pan-Africa Chemistry Network. It is not the first time she has received international recognition for her work in chemistry and nanotechnology. In 2009, she became the first South African scientist in Physical Sciences and one of only five women in the world to win the prestigious L'Oréal-United Nations Educational, Scientific and Cultural Organisation Award for Women in Science.

South Africa's Professor Malegapuru Makgoba was elected vice-president of the International Council for Science in October 2011. Makgoba is a trained physician and an internationally recognised molecular immunologist. He will serve as vice-president for three years, while continuing to serve as vice-chancellor of the University of KwaZulu-Natal. Makgoba was also the recipient of the 2011 National Research Foundation President's Lifetime Achievement Award.

from an early age, and encourages the country's youth to participate in science.

- The South African Nanotechnology Strategy aims to increase the number of nanotechnology characterisation centres in South Africa. The Nanotechnology Equipment Programme, which resides in the NRF, provides the infrastructure that forms the foundation of nanotechnology flagship research projects.
- The departments of labour, basic education, higher education and training, and science and technology are responsible for ensuring that training in scarce skills takes place, especially in the fields of S&T. The NRF manages the funds allocated for this purpose.

The NRF contributes to the Department of Science and Technology's 10-year Innovation Plan through developing:

- knowledge capital
- human capital
- knowledge infrastructure.

Business units Research and Innovation Support and Advancement

Risa is the agency that translates government's S&T strategies and policies into programmes and initiatives that support research institutions and researchers.

Risa promotes and supports research and research-capacity development in all fields of knowledge and technology by:

- investing, on a competitive basis, in knowledge, people and infrastructure
- developing research capacity and advancing equity and equality to unlock the full creative potential of researchers
- assisting with the development of institutional capacity at HE institutions
- facilitating strategic national and international partnerships and knowledge networks
- supporting science advancement through science awareness platforms, communication and education.

South African Agency for Science and Technology Advancement

As a business unit of the NRF, Saasta's mandate is to advance public awareness, appreciation and engagement of SET in South Africa. Through its outreach and awareness programmes, Saasta aims to entice students to pursue careers in science, and to instil enthusiasm and appreciation for science and its application in people's everyday lives. Saasta provides the infrastructure and competency platform to spread the message about science to learners, educators and the public.

All Saasta initiatives – from its travelling exhibits and competitions through to educator and learner programmes – fall under three key strategic areas:

- Education: through which Saasta builds up a supply of future scientists and innovators. The initiatives under this umbrella are:
 - school science support
 - SET careers
 - science resources.
- Communication: through which Saasta shares S&T achievements with the public to encourage an enthusiasm and appreciation of science benefits. The initiatives under this umbrella are:
 - science and the media
 - science promotion
 - science communication and capacity-building.
- Awareness: through which Saasta engages the public with the phenomena of SET.

Saasta, through a combination of in-house facilities and programmes, outreach and mobile awareness initiatives, competitions, festivals and events such as INSITE, SciFest African, National Science Week and Sasol Techno-X, have gone a long way towards clarifying the role of science in a fun and practical way for learners. The

In August 2011, the Department of Science and Technology's National Science Week embraced several social media platforms to more effectively achieve its science awareness objectives.

The 2011 event, held at over 90 venues countrywide, used various Internet-based communities, including Facebook and Twitter, to further promote an awareness and appreciation of science in South African society. The theme was *The Role of Science in Economic Development*.

Since its inception in 2000, National Science Week has taken science, engineering and technology to over 500 000 learners.

awareness unit manages an impressive collection of travelling exhibits and programmes that help to spread the word on science at festivals and through exhibitions throughout the year, and around the country.

National research facilities

The seven national research facilities managed by the NRF are clustered on the basis of their areas of specialisation aligned to the science missions of the NRDS.

South African Astronomical Observatory

The SAAO is the national centre for optical and infrared astronomy in South Africa. It is a facility of the NRF under the Department of Science and Technology. Its prime function is to conduct fundamental research in astronomy and astrophysics by providing a world-class facility and by promoting astronomy and astrophysics in southern Africa. The SAAO headquarters are in Observatory in Cape Town. The main telescopes used for research are located at the SAAO observing station near Sutherland in the Northern Cape.

It is also responsible for managing the operations of the Salt.

Hartebeesthoek Radio Astronomy Observatory (HartRAO)

The HartRAO has been established as the national facility for radio-astronomy research in South Africa. Its primary function is to support research and training in radio astronomy and space geodesy.

South African Institute for Aquatic Biodiversity (Saiab)

The Saiab serves as a research hub for aquatic biodiversity in southern Africa by housing and developing the National Fish Collection and associated resource collections as research tools and sources of aquatic biodiversity data.

It also generates knowledge on aquatic biodiversity through interactive and collaborative scientific research, and disseminates scientific knowledge at all levels.

The Saiab Collection Facility has about 80 000 fish specimens and contains at least 650 000 individual fish specimens.

The National Zoological Gardens has been involved in efforts to ensure the long-term survival of the Arabian Oryx (*Oryx leucoryx*). In June 2011, it announced that the species had been officially declared less threatened in the 2011 *Red List* of the International Union for Conservation of Nature and down-listed to "vulnerable".

South African Environmental Observation Network (Saeon)

The Saeon establishes and maintains nodes (environmental observatories and field stations or sites) linked to an information-management network. These nodes serve as research and education platforms for long-term studies of ecosystems that aim to advance the understanding of ecosystems and enhance the ability to detect, predict and react to environmental change.

National Zoological Gardens (NZG)

The NZG plays a major role in the ex-situ conservation of wildlife, maintaining one of the largest animal collections in Africa, made up of over 7 000 individual animal specimens representing over 600 species.

These are managed across four sites stretching into the provinces of Gauteng, Limpopo and North West. African species comprise about 70% of the animal collection and global species 30%.

As a member of the World Association of Zoos and Aquaria, the NZG participates in several endangered-species management programmes and successfully breeds several endangered species of continental and global significance.

In 2011, five years of collaborative research carried out by the NZG and several international institutions on cheetah populations in Africa and Asia culminated in a new conservation approach that will ensure the survival of the species.

iThemba Laboratory for Accelerator-Based Sciences

The iThemba Laboratory for Accelerator-Based Sciences is a group of multidisciplinary research laboratories administered by the NRF. Based at two sites in the Western Cape and Gauteng, these provide facilities for:

- basic and applied research using particle beams

- particle radiotherapy for the treatment of cancer
- the supply of accelerator-produced radioactive isotopes for nuclear medicine and research.

Science councils

The statutory science councils are a key part of South Africa's NSI. Through them, government is able to directly commission research in the interest of the nation, and support technology development in its precompetitive phase.

Agricultural Research Council (ARC)

The ARC was established by the Agricultural Research Act, 1990 (Act 86 of 1990), and is the principal agricultural-research institution in South Africa. It conducts fundamental and applied research with partners to generate knowledge, develop human capital and foster innovation in agriculture by developing technology and disseminating information. It also commercialises research results.

Six objectives form the basis of its strategic plan:

- generating, developing and applying new knowledge and S&T for agriculture to meet the demands for increased food production, food security and poverty alleviation
- promoting the sustainable use and management of natural resources to ensure a competitive agriculture sector and increasing wealth for people and industries dependent on natural resource-based agriculture
- improving nutrition and food security and safety by improving crop and livestock production systems, including seed security
- providing information and technical solutions that enable the agriculture sector to manage and mitigate agricultural risks, including threats to the agricultural production value chain from natural disasters, diseases, pests and agricultural practice
- disseminating information and transferring technology emanating from R&D
- achieving organisational growth and sustainability.

The ARC's functions are carried out through 11 research institutes whose activities are grouped under five divisions:

- field crops (grain and industrial crops)
- horticulture
- animal production and health

In 2011, the Department of Science and Technology provided skills-development training in intellectual property management at two summer schools in collaboration with the World Intellectual Property Organisation (WIPO). Further training throughout the year was supported by WIPO, Oxford University's Isis Innovation and Waikatolink of New Zealand's University of Waikato.

- natural resources and engineering
- technology transfer.

The ARC is also responsible for maintaining national assets and undertaking programmes or rendering services that are required from time to time by the department and other stakeholders.

Council for Scientific and Industrial Research

The CSIR's mandate is stipulated in the Scientific Research Council Act, 1998 (Act 46 of 1988), as amended by Act 71 of 1990, Section Three.

The CSIR aims to foster industrial and scientific development, either by itself or in cooperation with principals from the private or public sectors, thereby contributing to the improvement of the quality of life of the people of South Africa, through directed and particularly multidisciplinary research and technological innovation.

The CSIR is one of the leading S&T, R&D and implementation organisations in Africa, with its main site in Pretoria. The organisation is represented in other provinces of South Africa through regional offices.

The generation and application of knowledge resides at the core of the CSIR. It transfers the knowledge generated through research activities by means of technology and skilled people.

Research areas include:

- biosciences
- built environment
- defence, peace, safety and security
- ICT
- laser technology
- materials science and manufacturing
- modelling and digital science
- mineral resources
- space technology
- natural resources and the environment
- mobile intelligent autonomous systems
- nanotechnology
- synthetic biology.

One of the Council for Scientific and Industrial Research's highlights in 2011 was the development of a new fingerprint classification and recognition technique. The structural fingerprint classifier can correctly classify a fingerprint with only partial information, which is a world first.

In 2011/12, R687 million was allocated to the CSIR.

Mintek

Mintek, South Africa's national mineral research organisation, is one of the world's leading technology organisations specialising in mineral processing, extractive metallurgy and related areas. Working closely with industry and other R&D institutions, Mintek provides service testwork, process development and optimisation, consulting and innovative products to clients worldwide.

Mintek is an autonomous statutory organisation, which reports to the Minister of Minerals and Energy. About 35% of the annual budget is funded by the State Science Vote, with the balance provided by contract R&D, sales of products and services, technology licensing agreements and joint-venture private-sector companies. Mintek has about 780 permanent staff members, more than half of whom are scientists, engineers and other technical R&D specialists.

Mintek's key objectives include:

- developing efficient mineral-processing technologies and sustainable value-added products and services
- Second-Economy interventions
- human and organisational development
- good governance.

The Department of Mineral Resources granted Mintek R90 million over the 2011/14 period for the rehabilitation of derelict and ownerless mines in South Africa.

Human Sciences Research Council

The core business of the HSRC is to conduct large-scale, policy-relevant, social-scientific projects for public-sector users, non-governmental organisations (NGOs) and international development agencies. This is done in partnership with researchers globally, but specifically in Africa.

As the national social-science council of South Africa, the HSRC serves as knowledge hub to bridge the gap between research, policy and action; thus increasing the impact of research.

This is achieved through collaboration with key constituencies, including government, other research organisations, multinational agencies, universities, NGOs, and donor and development organisations.

With a staff complement of almost 500, comprising professional researchers, as well as technical and administrative support staff, based in six offices in four different provinces across South Africa, the HSRC is well equipped to respond flexibly and comprehensively to current and emerging needs. Its six multidisciplinary research programmes and research centres are focused on user needs. The following units make up the HSRC:

- Education and Skills Development
- Economic Performance and Development
- Population Health, Health Systems and Innovation
- HIV, AIDS, Sexually Transmitted Infections (STIs) and TB (including the Africa-wide research network, Social Aspects of HIV/AIDS Research Alliance)
- Democracy, Governance and Service Delivery
- Human and Social Development.

The HSRC operates two centres, namely the Centre for Science, Technology and Innovation Indicators; and the Centre for the Study of the Social and Environmental Determinants of Nutrition.

In 2010/11, the HSRC undertook more than 150 projects and an assortment of initiatives.

Medical Research Council

The MRC was established in July 1969 as an independent statutory body to coordinate health and medical research activities throughout South Africa, operating as a statutory science council functioning within the ambit of the MRC Act, 1991 (Act 58 of 1991), as well as the Public Entities Act, 1997 (Act 30 of 1997).

The MRC's objectives are:

- promoting health and quality of life of South Africa's population
- performing such functions as may be assigned to the MRC by or under this Act.

Health RDI is the core business of the MRC. During the past five years, the MRC research priorities were defined in a way that recognises the complementary relationships of three quite different, but synergistic, focal areas of health research:

- the population's health
- disease and disease mechanisms
- systems, settings and policy.

The MRC falls under the ambit of the Department of Science and Technology and the NSI, while having a direct line function with the Department of Health. A major goal set by government in the Medium Term Strategic Framework for 2009 to 2014 is to improve the health profile of all South Africans – in line with the aims of the South African Constitution.

The Department of Science and Technology and other departments have committed to help achieve this goal. The Department of Health adopted a new set of priorities called the 10-Point Plan, with a focus on four output areas which are part of the Health Service Delivery Agreement:

- increasing life expectancy
- decreasing maternal and child mortality rates
- combating HIV, AIDS and STIs
- decreasing the burden of disease from TB
- strengthening health-system effectiveness.

These outputs link to the millennium development goals four, five and six respectively; addressing child mortality, maternal health and combating HIV and AIDS and other diseases.

Council for Geoscience (CGS)

The CGS is the legal successor of the Geological Survey of South Africa, which was formed in 1912 by the amalgamation of three former surveys, the oldest of which – the Geological Commission of the Cape of Good Hope – was founded in 1895.

The Geoscience Act, 1993 (Act 100 of 1993), established the CGS in its present form. The council is a modern institution, boasting excellent facilities and expertise, ranking among the best in Africa.

The Geoscience Amendment Act, 2010 (Act 16 of 2010), amends the Geoscience Act, 1993 to mandate the CGS to be the custodians of geotechnical information; to act as a national advisory authority in respect of geohazards related to infrastructure and development; and to undertake exploration and prospecting research in the mineral and petroleum sectors.

A state-of-the-art electronic corporate relational database, which integrates dedicated modular databases for specific applications such as mineral deposits, boreholes, geochemistry and engineering geology into a comprehensive Geographic Information System, has been developed.

The drawing office produces a wide variety of geoscientific maps, using both conventional and electronic cartographic technologies.

The activities of the CGS include:

- geological, metallogenic and geotechnical mapping
- economic geology
- engineering geological site investigations
- airborne and ground-based geophysical surveys and interpretations
- geochemical surveys
- seismology
- ground-water investigations
- coastal-erosion studies
- marine geology
- environmental impact assessments
- palaeontology
- geographic information system development and spatial database design
- laboratory services
 - wet-chemical determinations
 - geotechnical analytical services
 - optical- and electron microscopy
 - petrographic descriptions
 - mineralogy
 - X-ray diffractometry
 - X-ray fluorescence
- data analysis, design and compilation of geoscience databases
- information management and dissemination
- map production:
 - geological maps
 - geophysical maps, including magnetic, radio-metric and gravity maps
 - seismic hazard maps
 - metallogenic maps
- geoscience publications in various formats.

The National Geoscience Library contains a comprehensive collection of geoscience publications in South Africa, consisting of about 17 000 books and more than 2 800 journal titles.

The Map Library has a collection of more than 14 000 sheet maps, with a large portion of this collection devoted to maps of Africa.

The CGS maintains a prospecting borehole-log collection of over 72 000 borehole logs acquired from prospecting and mining companies.

The national Geoscience Museum provides educational facilities and information to scholars, tourists and members of the public in the form of displays; multimedia kiosks; rock-, mineral- and fossil-identification services; brochures; and

worksheets. The museum's gem, mineral, meteorite and rock collection is recognised as one of the best of its kind in Africa.

The National Core Library contains a large collection of borehole cores and cuttings from South African geological strata, collected over a period of more than 25 years.

South African Bureau of Standards (SABS)

The SABS is a statutory body that operates in terms of the Standards Act, 2008 (Act 8 of 2008), as the national institution for the promotion and maintenance of standardisation and quality in connection with commodities and the rendering of services. The SABS:

- publishes national standards, which it prepares through a consensus process in technical committees
- provides information on national standards of all countries as well as international standards
- tests and certifies products and services to standards
- develops technical regulations (compulsory specifications) based on national standards, and monitors and enforces compliance with such technical regulations
- monitors and enforces legal metrology legislation
- promotes design excellence
- provides training on aspects of standardisation.

To maximise its service delivery to the industries it serves, the SABS aligned its activities with seven different industry sectors, each housing the whole range of the SABS services pertinent to a particular industry.

This ensures easy access to products, faster reaction and turnaround times, and the creation of centres of knowledge excellence that will be easily available to clients. The seven industry sectors are:

- chemicals
- electrotechnical
- food and health
- mechanical and materials
- mining and minerals
- services
- transportation.

In October 2011, President Jacob Zuma officially opened the SABS' new testing laboratories in Pretoria. These will play a critical role in the SABS' conformity assessment services and improve customer services.

In November 2011, the SABS hosted the 13th International Meeting of the International Standardisation Organisation Technical Committee, 229 Nanotechnologies. International standardisation plays a critical role in ensuring that the full potential of nanotechnology is realised and that nanotechnology is safely integrated into society.

Other scientific and research organisations and structures Eskom

Eskom's Technology Services International group is a multidisciplinary industrial laboratory and consulting organisation. It undertakes testing, investigation studies, project management, engineering services and applied research for Eskom and other customers.

Sasol

Sasol's culture of innovation began in the 1950s when it developed its unique blend of coal gasification and Fischer-Tröpsch (FT) technology for its original coal-to-liquids operations at Sasolburg. It has since evolved these operations into fully fledged R&D facilities that form the heart of the Sasol Technology R&D group. Focused FT R&D in the 1980s and 1990s led to the development of the low temperature FT Sasol Slurry Phase process used at Sasolburg, and the high-temperature Sasol Advanced Synthol™ Process used at Secunda.

Sasol Technology's Fuels Technology Division carries out work concerning fuels, lubricants, heating-fuel and road-binding material, R&D and new-product formulation and testing at Sasolburg.

In addition, Sasol opened the Sasol Fuels Application Centre (SFAC), a state-of-the-art engine and exhaust emission testing and research facility, in Cape Town. The SFAC enables Sasol to conduct sea-level engine and emission tests in line with international standards.

In October 2011, the Department of Science and Technology and Sasol ChemCity launched a plant-oils and -extracts facility in Tzaneen, Limpopo, in an effort to create sustainable livelihoods in the area. The Nkowankowa Demonstration Centre will run a R13,9-million development project over the next three years, extracting various fruit and plant oils with a view to establishing their viability in the cosmetics sector.

Funded by the Department of Science and Technology, the establishment of the facility is informed by the department's objective to apply

innovative technology to local natural resources to create sustainable employment in areas of need.

ArcelorMittal

ArcelorMittal is a global steel-maker, with an industrial presence in 27 countries. It is a leader in all major global markets, including automotive, construction, household appliances and packaging.

The group is a leader in R&D and technology, holds sizeable captive supplies of raw material and operates extensive distribution networks.

National Health Laboratory Service (NHLS)

The NHLS forms a national network of integrated pathology laboratories that use common laboratory management systems and transport networks to facilitate the transport of specimens, referral of tests to reference laboratories and delivery of results.

The NHLS has 265 laboratories and employs about 6 500 people. Their activities comprise diagnostic laboratory services; research, teaching and training; and producing sera for anti-snake venom, reagents and media. All laboratories provide laboratory diagnostic services to the Department of Health, provincial hospitals, local authorities and medical practitioners.

Research conducted by the NHLS covers a wide spectrum of activities in all pathology disciplines. Grants in support of research are made by the MRC, the Cancer Association of South Africa, the South African Sugar Association, Poliomyelitis Research Foundation, pharmaceutical companies, private donors and a number of overseas institutions, among others. A large part of the research programme is financed by the NHLS itself from the earnings of its laboratory services.

Bureau for Economic Research (BER)

The BER at the University of Stellenbosch, Western Cape, is an independent economic research organisation. It renders a service to organisations ranging from small one-person businesses to policy-makers at the highest level of government.

National Institute for Tropical Diseases

The National Institute for Tropical Diseases in

Tzaneen, Limpopo, is responsible for the ongoing assessment of malaria-control programmes carried out by various authorities in South Africa.

Control methods are assessed and recommendations made to the appropriate authorities regarding equipment, insecticide usage and application. A malaria-reference service is also provided. Malaria tests are carried out by the institute, and statistical analyses of data pertaining to the programme are undertaken.

Institute for Economic Research on Innovation (Ieri)

Ieri was established as a public-good research organisation with a core competence in the analysis of systems of innovation.

Its mandate is to provide research, capacity-building and community engagement in this field of study. Its tasks involve:

- conducting research on the political economy and policy dimensions of innovation and development
- contributing thought-leadership on the relationship between knowledge and development across economic, social and political domains
- building capabilities and competencies in the understanding of the political economy and policy dimensions of innovation and development
- focusing across local, provincial, national, regional and international geographies.

Institute for Security Studies (ISS)

The ISS works towards a stable and peaceful Africa characterised by sustainable development, human rights, the rule of law, democracy, collaborative security and gender mainstreaming.

The ISS realises this vision by:

- undertaking applied research, training and capacity-building
- working collaboratively with others
- facilitating and supporting policy formulation
- monitoring trends and policy implementation
- collecting, interpreting and disseminating information
- networking on national, regional and international levels.

Africa Institute of South Africa (Aisa)

The Aisa was first established in 1960 as a non-profit organisation. It is a statutory body following the Aisa Act, 2001 (Act 68 of 2001).

The organisation has long been at the forefront of research and training on African affairs. The Aisa has contributed to fostering a new generation of research specialists, and has also been able to produce some of the finest research on contemporary African affairs by having its researchers conduct field research every year throughout the African continent.

It is involved in community outreach programmes, providing maps and other resources to underprivileged schools in rural South Africa.

The department allocated R32 million to the Aisa in 2011/12.

General research areas

Mine-safety research

The activities of the Safety in Mines Research Advisory Committee are aimed at advancing the safety of workers employed in South African mines. The committee is a statutory tripartite sub-committee of the Mine Health and Safety Council. It has a permanent research-management office managing the rock engineering, engineering and mine occupational health fields of research.

Energy research

South Africa's National Energy Research Institute (Saneri) is the public entity entrusted with the coordination and undertaking of public-interest energy research, development and demonstration. Saneri was established in October 2004 as a subsidiary of the Central Energy Fund (Pty) Ltd, the State energy company in South Africa.

In August 2011, the Minister of Science and Technology, Ms Naledi Pandor, presented the Women in Science Awards to the country's leading female scientists.

The awards were part of the department's efforts to increase the number of female scientists and researchers in the country. They were also created to raise women's access to research professions and profile successful scientists and researchers as role models for younger women.

Awards were made in the following fields:

- Distinguished Women Awards:
 - Life Sciences: Prof. Quarraisha Abdool Karim
 - Social Sciences and Humanities: Prof. Aimee Vivienne Stewart
- Indigenous Knowledge Systems: Prof. Namrita Lall
- Distinguished Young Women Awards:
 - Life Sciences: Prof. Jolanda Roux
 - Social Sciences and Humanities: Prof. Pear Mplenhle Sithole
- Doctoral fellowships:
 - Tricia Naicker, Aisha-Bibi Pandor and Karen Pillay
- Master's fellowships:
 - Anneke Perold, Narine van den Berg and Anna Zawilska.

The Department of Science and Technology, together with the departments of mineral resources and energy, are joint custodians of Saneri and assist in providing political and strategic focus for the company.

Agricultural research

The ARC, several universities and various private-sector organisations conduct agricultural research. Provinces are responsible for farm management and technological development. These activities are aimed at improving managerial efficiency on farms.

The Directorate: Scientific Research and Development in the Department of Agriculture, Forestry and Fisheries coordinates all agricultural R&D activities.

The National Agricultural Research Forum (NARF) coordinates agricultural R&D within the national agricultural research system. The NARF also provides a platform for stakeholder consultations on R&D matters.

Biannual meetings are held to debate and decide on research needs, programmes and budgeting. Efforts are made to ensure that the bulk of research serves the needs of small-scale producers.

Research initiatives have been integrated into the various industries in line with the overall objectives of each agricultural sector.

Water research

The Water Research Commission (WRC) was established in 1971 through the Water Research Act, 1971 (Act 34 of 1971), following a period of water shortages. The WRC is responsible for:

- promoting coordination, cooperation and communication in the area of water R&D
- establishing water-research needs and priorities
- stimulating and funding water research according to priority
- promoting the effective transfer of IT
- enhancing knowledge and capacity-building within the water sector.

The WRC functions as a "hub" for water-centred knowledge. This is reflected in the WRC's mission, which provides the organisation with a framework for its strategic and operational initiatives. The WRC functions as a networking organisation, linking the nation and working through partnerships. Being an innovation organisation, it is continuously providing novel (and practical)

ways of packaging and transferring knowledge into technology-based products for the water sector and the community at large, both locally and globally.

Many decades of R&D and science-based knowledge have provided the basis for the development of policies and strategies that allow for the sustainability of South Africa's water resources.

This emphasises not only the important role that water-centred knowledge has played in the past, but also its increasingly important role in providing South Africa with knowledge, which will allow it to deal successfully with the many new challenges that limited water resources will bring about in future years. The WRC plays a crucial role in this regard. It leads and coordinates research, which, in turn, creates the knowledge that facilitates the judicious management of water quantity and quality, in order to achieve sustainability.

The Water Research Act, 1971 established the Water Research Fund, which derives income primarily from levies on water consumption.

In supporting the creation, dissemination and application of knowledge, the WRC focuses on five key strategic areas:

- water-resource management
- water-linked ecosystems
- water use and waste management
- water use in agriculture
- water-centred knowledge.

The WRC also calls for specific mechanisms to address key strategic issues of national importance. These issues are dealt with in four cross-cutting domains:

- water and society
- water and the economy
- water and the environment
- water and health.

The organisations that participate in water research are:

- universities and universities of technology
- professional consultants
- science councils
- water and waste utilities
- NGOs.

The main areas of research are surface hydrology, groundwater, hydrometeorology, agricultural water use, water pollution, municipal effluents, industrial water and effluents, drinking water, membrane technology, water ecosystems, hydraulics, mine-water management, water policy, developing communities and the transfer of technology.

Held in May 2011, South Africa's annual National Science Festival Scifest Africa 2011 attracted 65 000 visitors.

With the theme, *Science across Cultures*, Scifest offered lectures, workshops, exhibitions and other interactive activities that covered topics such as paint-making, micro-rockets, lasers, weather prediction, supersonic cars, laser beams, astronomy and kitchen chemistry.

The Division: Water, Environment and Forestry Technology (Environmentek) of the CSIR specialises in research into water quality, including technology to meet effluent and water-quality standards, and to establish reclaimed water as an additional water source.

Environmentek is a world leader in research into activated sludge processes and the biological monitoring of water to detect potentially toxic substances. It is also involved in research into the effects of afforestation and veld management on the quantity and quality of catchment water-yield.

Institute for Water Research (IWR)

The IWR is a multidisciplinary research department of Rhodes University. Its main objective is to contribute to sustainable water-resource management in southern Africa.

This is achieved through scientific research into the structure and function of aquatic ecosystems; the application of research through specialist consultancy services; tertiary-level teaching and training; capacity-building for community development; and service on national and international management and policy-making committees.

Environmental research

The Department of Environmental Affairs annually finances several research and monitoring programmes.

They cover subjects such as waste management and pollution, nature conservation, river management, coastline and marine environment, and the atmosphere.

Some programmes are conducted in collaboration with the NRF, while others are undertaken on behalf of the department by the CSIR and universities. Research into human-environment interaction, sponsored by the department, is coordinated by the HSRC.

In addition, institutes of the ARC are concerned with environmental research insofar as environmental problems impact on agriculture or are caused by agricultural practices.

The South African Weather Service (SAWS) is a statutory body functioning under the Department of Environmental Affairs.

The SAWS delivers public-good services, mainly for the protection of life and property, as well as commercial services to the private sector, as stipulated in the Weather Service Act, 2001 (Act 8 of 2001).

Among other activities, the SAWS runs the Global Atmospheric Watch Programme, which measures and monitors greenhouse gas datasets. The SAWS has also rolled out a number of ozone-monitoring stations in the SADC region.

The NRF directs the multidisciplinary Conservation and Management of Ecosystems and Biodiversity Focus Area, primarily in collaboration with universities and museums, to promote and support research into living resources and terrestrial, freshwater, marine, coastal and atmospheric ecosystems.

South African National Biodiversity Institute (Sanbi)

Sanbi's biodiversity research comprises collaborative programmes set up to promote and catalyse knowledge about biodiversity.

The broad scope of research includes the origins, composition and functioning of biodiversity, its conservation and sustainable use, ecosystem services and biodiversity responses to major drivers such as climate change. The research is organised into three divisions:

- Applied Biodiversity Research
- Biosystematics Research and Biodiversity Collections
- Climate Change and Bio-Adaptation.

Fisheries research

Research into South Africa's fish resources and their conservation and judicious exploitation, is carried out by research personnel of the Chief Directorate: Marine and Coastal Management, a division of the Department of Environmental Affairs, and by several universities and NGOs.

Research is designed to provide parameters for estimates of stock sizes and sustainable yields for the different fisheries.

Coastal and marine research

The NRF supports marine and coastal research in partnership with the Department of Environmental

Affairs and the South African Network for Coastal and Oceanic Research. The Chief Directorate: Marine and Coastal Management advises on the use of marine living resources and the conservation of marine ecosystems, by conducting and supporting relevant multidisciplinary scientific research and by monitoring the marine environment.

Sustainable use and the need to preserve future options in using marine ecosystems and their resources are guiding objectives in the research and advice provided by the chief directorate.

Private-sector involvement

South Africa's gold-mining industry works at deeper levels and under more difficult conditions than any other mining industry in the world. The research into gold mining conducted by the CSIR's Mining Technology Group is concerned primarily with ensuring the health and safety of the workforce. It includes those working in the areas of rock engineering and the underground environment.

Mining Technology's coal-mining research takes place on a smaller scale than that of gold mining, because the coal-mining industry is able to make use of various developments overseas.

Areas in which research is undertaken include strata control, mining, maximising the extraction of coal and the underground environment.

Research is also carried out by a large number of industrial companies with facilities to meet their specific needs.

The more important ones are the:

- Anglo American Corporation of South Africa (applied metallurgy, processing of precious metals, base metals and coal)
- Agricura (synthesis and testing of veterinary remedies, insecticides, herbicides and entomology)
- Cullinan Holdings (refractories and electrical porcelain)
- De Beers Industrial Diamond Division (manufacturing and application of synthetic diamonds and other super-hard material)
- Johannesburg Consolidated Investment Company (metallurgy, mineralogy, chemistry and chemical engineering)
- National Chemical Products (chemistry, microbiology and animal nutrition)

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- Metal Box Company of South Africa (corrosion mechanisms and microbiology)
 - Tellumat (development of electronic instruments)
 - Rembrandt Group (development and improvement of tobacco and liquor products)
 - South African Pulp and Paper Industries (wood technology, paper manufacturing and water treatment)
 - Standard Telephones and Cables South Africa (long-distance transmission of information and lightning protection).

Acknowledgements

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