



SA YEARBOOK 2009/10
SCIENCE AND TECHNOLOGY



South Africa's scientists and infrastructure are world-class and the country is rapidly positioning itself among the global leaders in innovation, science and technology (S&T).

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

Policy framework

The framework for the work of S&T in South Africa was set in 1996 in the *White Paper on Science and Technology*, which established the concept of the National System of Innovation (NSI) and the need to harness S&T to contribute to economic growth, environmental sustainability and an improved quality of life.

The ideas of the White Paper were taken further in the 2002 National Research and Development Strategy (NRDS), which rests on the pillars of innovation to achieve mastery of technological change in the economy and society; human-capital development and transformation to increase investment in South Africa's science base; and alignment of the Government's S&T system to make it more effective.

It called, among other things, for a substantial increase in national expenditure on research and development (R&D), which in 1994 was a mere 0,7% of gross domestic product (GDP).

Expenditure on research and development

The Department of Science and Technology had been given the task of developing the National S&T Expenditure Plan to provide a coherent approach to government's S&T investment.

Over the past five years, government has improved funding to S&T and innovation. The budget has grown from R2 billion in 2005/06 to R5,1 billion projected for 2011/12. In the 2009/10 financial year, the budget was R4,2 billion.

Moreover, in 2006, South Africa's gross expenditure on R&D was more than R16,5 billion.

Although this is close to the target of 1% of GDP, the investment is modest, and it is time the target is increased beyond the 1% of GDP funding for research.

To encourage private-sector investment in R&D, the R&D Tax Incentive Programme was introduced, giving a 150% deduction on eligible

activities, and an accelerated depreciation allowance on assets used for R&D over three years, at a rate of 50:30:20.

While the South Africa's Revenue Service administers the R&D tax incentives, the Department of Science and Technology collects information on the programme to evaluate its effectiveness.

As uptake increases, more detailed statistics will become available. Annual national surveys on R&D are carried out to measure the country's progress in S&T and innovation.

These give information on expenditure in R&D by major research field and type of research, as well as on the number of full-time equivalent researchers in the country, and their demographic make-up.

Human-capital development

In the 2008/09 budget, some R195 million was set aside to strengthen the scientific capacity of higher education (HE) institutions, which includes increasing the number of research chairs by creating and filling 210 new research chairs by 2010, under the South African Research Chairs Initiative.

Over the medium term, about R323 million had been allocated to the development and renewal of science, engineering and technology (SET) human capital. This would include strengthening programmes such as the Research Professional Development Programme, which targets young students doing senior SET degrees, the Postdoctoral Fellowship Programme and the Centres of Excellence Programme.

This investment is in line with the NRDS, which places enormous value on human-capital and skills development, as South Africa's HR for SET are not being increased and renewed at the rate required to keep the country competitive in an increasingly knowledge-based global economy.

In 2009, the Department of Science and Technology was committing R150 million over three years for new research chairs. By December 2008, 72 research chairs had been awarded in key areas aligned to the national priorities, and a total of 374 post-graduate students had been supported through supervision or mentorship.

In 2009, 10 more research chairs were awarded, bringing the total to 82.



One of South Africa's most important initiatives to address this problem is the Youth into Science Strategy. Among other projects, it develops and distributes information about careers in SET, nurtures young people with talent and potential through Science and Mathematics camps and olympiads (particularly those from disadvantaged backgrounds) and equips Science and Mathematics teachers with the skills they need through an educator support programme.

The Women in Science Awards encourage women to enter and remain in SET careers.

The country's National Research Foundation (NRF) has established several centres of excellence to take the lead in their respective disciplines (biomedical tuberculosis [TB] research, birds as key to biodiversity conservation, invasion biology, tree-health biotechnology, catalysis, strong materials, and epidemiological modelling and analysis).

They work at the cutting edge of research and collaborate with top researchers and leading laboratories all over the world, producing substantial research output and providing excellent training and support for postgraduate students and future researchers.

Other centres of excellence are planned, including one for indigenous knowledge systems (IKS).

Indigenous knowledge systems

The importance of identifying and protecting indigenous knowledge is receiving increasing attention from policy-makers the world over.

South Africa's IKS policy was approved by Cabinet in 2004, and in 2006 the national IKS Office was established to foster a better understanding of the interface between culture and S&T, as well as between indigenous and Western knowledge systems. The Ministerial Advisory Committee for IKS was established.

Government is planning to develop IKS databases, including a multimedia recordal system, following an audit of those residing at various institutions.

The first IKS Research Chair on Traditional Medicine, based at the Nelson Mandela School of Medicine in the Eastern Cape, is expected to lead the production of knowledge on traditional medicines that could result in the development of health products to cure diseases.

The development of the Bachelor of IKS qualification started in 2006 and was completed in 2008. The qualification was developed in collaboration with the North West University, University of Limpopo and Venda University.

The South African Qualifications Authority (Saqqa) guided the Department of Science and Technology and its partners throughout the process of developing the qualification until it was registered with Saqqa in November 2008.

It is a four-year professional degree with six main streams covering indigenous knowledge development and management, public health and medicine, food technology, socio-ecological studies, law and African technological innovations.

The Department of Science and Technology is in the process of marketing the qualification while at the same time developing unit standards for the courses under each stream. The honours and masters qualifications were developed and submitted to Saqqa in June 2009 and the outcome was expected to be submitted to the Department of Science and Technology in November 2009.

Plans are underway to use the North West University as a pilot as of 2010, since the Mafikeng Campus has an established IKS within the Department of Arts and Culture. Lessons learnt from the pilot will be used to implement the qualification in other universities throughout the country from 2011.

Ten-Year Innovation Plan

In 2008, Cabinet approved the 10-Year Innovation Plan for South Africa, intended to provide strategic leadership and direction for S&T in pursuit of national socio-economic goals. It aims to bridge the innovation chasm, ensuring that knowledge generated by research is developed into marketable products and services.

The plan focuses on the following five "grand challenges":

- Farmer to Pharma (aimed at strengthening the bio-economy and making South Africa a world leader in biotechnology and pharmaceuticals, using the nation's indigenous resources)
- Space S&T (making South Africa a key contributor to global space S&T with the National Space Agency, a growing satellite industry, and a range of innovations in space sciences, Earth observation, communications, navigation and engineering)
- Energy Security (ensuring a safe, clean, affordable and reliable energy supply for South Africa)
- Global Change Science (using South Africa's geographic position to play a leading role in climate-change science)
- Human and Social Dynamics (contributing to a better global understanding of shifting social dynamics, and the role of science in social dynamics).

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 Act, 2008 (Act 36 of 2008).

The National Space Agency 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 of intellectual property derived from publicly financed R&D for the benefit of all South Africans.

It establishes the National Intellectual Property Management Office and provides for the establishment of offices of technology transfer at institutions.

The Technology Innovation Agency (TIA) Act, 2008 (Act 26 of 2008), provides for the establishment of the TIA to help stimulate scientific innovation in the country.

Science bodies

These include the:

- TIA
- Innovation Fund (IF)
- National Advisory Council on Innovation (Naci).

Technology Innovation Agency

The TIA was launched in 2009 and is intended to enhance the country's capacity to translate local

In March 2009, the Department of Science and Technology launched the National Space Policy Initiative. South Africa is increasingly reliant on space-based services for communications, broadcasting, navigation and Earth observation. The country is also emerging as a regional hub of space science and technology (S&T).

The Government Lead Users Group was established to compile a user-requirements document for government applications of space S&T. This document will highlight the uses of space technology among various government departments, thereby allowing potential synergies to be identified and potential duplication of effort and/or costs to be avoided. The work of the Government Lead Users Group is to be complemented by a document under development by the National Working Group on Space S&T, which will provide an analysis of the benefits of improved co-ordination in the South African space arena. These two discussion documents will be supplemented by the results of a survey of the South African space arena, which was conducted in early 2009.



R&D outcomes into commercialisable products and services.

This should result in the establishment of new high-tech companies, a wider tax base, the creation of new jobs, advanced technological solutions for socio-economic problems, exports of high value-added products, and a diversified export portfolio, moving away from dependency on natural resources.

This will be achieved by providing financial and non-financial support during the applied research and technology stages of the innovation value chain, sourcing foreign and domestic funding opportunities and facilitating strategic partnerships between HE and public research institutions, industry and relevant government players.

The agency aims to take over some of the budget and functions of existing programmes, such as the IF; Tshumisano; the Advanced Manufacturing Technology Strategy (AMTS); the Advanced Metals Initiative; the Hydrogen and Fuel Cell Research, Development and Innovation Strategy of South Africa; as well as the National Biotechnology Strategy (NBS).

Innovation Fund

The IF, managed by the NRF, promotes technological innovation through investments into novel technologies that will lead to established successful companies or the expansion of industrial sectors.

It has a series of investment instruments, structured to fund end-stage R&D, commercialisation, start-up companies and intellectual-property management. Between 1999 and 2009, the IF invested R1,2 billion in 270 projects.

These are specifically tailored to foster the pursuit of high-risk technologies by business entities, and by creating partnerships that draw on technical expertise in the public research enterprise.

The incentive to the business partners is the equal sharing of the R&D costs of the market-oriented research agenda.

The fund provides funding to near-market and end-stage research, which produces new intellectual property and commercial enterprises, and expands existing industrial sectors.

Of the fund's more recent projects, three contributed to protecting the ecosystem, reducing greenhouse-gas emissions (GHGs), and improving South Africa's global competitiveness. The first of the projects, the Industrial Plant Simulator, aimed to reduce the level of GHGs released into the atmosphere by making electricity power stations more efficient.

The second project was the Aircraft Laser Paint-Stripping Project, which used laser technology to reduce the amount of environmentally harmful chemicals used in paint stripping.

The third project was an investment into the development of the Joule, South Africa's first fully battery-operated multipurpose vehicle, by Optimal Energy, a company based in Cape Town. This will reduce GHGs, even when using coal-generated electricity.

Adept, a South African engineering company based in Cape Town, designed and built a sports aircraft, the Ravin 500. This is the first African-designed aircraft using an African-designed engine. The engine design is state-of-the-art with regard to internal combustion-engine technology, using the most advanced material and techniques (including electronic components) and is environment-friendly, with excellent fuel efficiency. The engine is not just suitable for new designs, but can also be fitted in existing aircraft.

Another R&D project consortium has led to the development of a process to manufacture thin film solar modules based on technology that uses elements that are alternative to the silicon-based modules.

In 2009, the solution developed was then the most efficient thin-film technology for the production of solar modules. Johanna Solar Technology,

an international company located in Germany, has been established to manufacture these modules.

The successful establishment of a solar-panel industry, driven by local expertise, will offer tremendous potential for addressing the economic and social challenges that South Africa faces.

HE students, particularly first-degree engineering students, can take advantage of the IF by developing projects resulting in the creation of new intellectual property or the establishment and/or expansion of commercial enterprises, as part of their final-year work.

National Advisory Council on Innovation

Naci is appointed by the Minister of Science and Technology to advise on the role and contribution of innovation, including S&T, in promoting and achieving national objectives. These include:

- improving and sustaining the quality of life of all South Africans
- developing HR for S&T
- building the economy
- strengthening the country's competitiveness in the international sphere.

Naci membership is broadly representative of all sectors and is constituted to ensure a spread of expertise and experience regarding national and provincial interests, scientific and technological disciplines, innovation regarding the needs and opportunities in different socio-economic fields, and R&D in all sectors.

Tshumisano

Tshumisano, a joint venture between government, the German Agency for Technical Cooperation and the Committee of University of Technology Principals, was established in 2002 to provide support for the small, medium and micro-entrepreneur (SMME) sector through its Technology Stations Programme.

One of the aims of this programme is to strengthen technological innovation activities and related skills-upgrading, increasing the relative competitiveness of SMMEs in targeted sectors such as automotive, agrifood processing, electronics, metal value-adding, chemicals, metal casting, and composite and moulded plastics sectors.

Technology stations are based at various universities of technology across the country and provide assistance to SMMEs by helping them to improve their operations through technology assimilation and by upgrading their innovation capabilities.

The annual Advanced Manufacturing Technology Strategy (AMTS) Symposium was held in September 2009.

The purpose of the symposium was to:

- create an information-sharing opportunity for the AMTS stakeholders
- highlight the impact of the AMTS
- report on the progress of technical and human-capital development projects
- present project progress and successes to the AMTS network and encourage cooperation and learning.

The AMTS develops critical competencies aimed at strengthening the technological base and competitiveness of the South African manufacturing sector. It has delivered some 25 world-class projects, valued at more than R140 million.

These include:

- a project to develop panels for aircraft interiors using natural fibres
- developing capabilities to produce high-quality casting from titanium alloys
- establishing advanced manufacturing technology laboratories.



Tshumisano has also rolled out three institutes for advanced tooling in Soshanguve, outside Pretoria (training and SMME development), East London (design) and Stellenbosch (R&D).

Advanced Manufacturing Technology Strategy

The AMTS guides efforts in the manufacturing sector, including the aerospace industry; develops technology platforms that increase current and create new competitive advantages; establishes partnerships and develops human capital; and enhances the knowledge base and intensity of South Africa's manufacturing sector.

The Centre for Innovation, focusing on craft and design, opened in Cape Town in July 2006. The centre was the first of its kind in the world and a state-of-the-art resourced venue aimed at promoting innovative design, product development and process technologies for crafters and designers.

It incorporates a fabrication laboratory, sponsored by the Massachusetts Institute of Technology (MIT). The centre's activities are linked to SMME development and market-access support programmes.

Government has set aside R16 million to establish 10 fabrication laboratories (FabLabs) around the country, providing disadvantaged communities with opportunities in the design, testing and fabrication process.

FabLabs are part of the department's provision of SET platforms for social development, but also benefit private-sector competitiveness and growth.

Advanced manufacturing technology is brought to ordinary people as an accessible platform to empower them through hands-on participation in an environment that enables the freedom to experiment and encourages peer-to-peer learning. FabLabs are co-sponsored by the MIT's Centre of Bits and Atoms.

Biotechnology

The NBS sets the agenda for the development of South Africa's biotechnology industry.

The biotechnology sector is attracting a fast-growing portion of R&D funding. South Africa is also committed to developing biotechnology in Africa. In August 2005, the Council for Scientific and Industrial Research (CSIR) initiated a southern regional hub of the New Partnership for Africa's Development's (Nepad) African Biosciences Initiative.

Research related to agriculture, human and animal health, environment and industry is being prioritised. Other initiatives include the establishment of biotechnology regional innovation centres (Brics), namely the Biotechnology Partnership for Africa's Development (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 subdisciplines in biotechnology. These include human and animal health, biopharmaceuticals, industrial bioprocessing, mining biotechnology, bioinformatics and plant biotechnology.

Over the past five years, they have supported the establishment of 30 new start-up biotechnology companies, stemming from university research and intellectual property generated by South African innovators. More than a 1 000 research jobs have been created. Innovative products and services are growing year-on-year.

One of the challenges facing the South African biotechnology sector is the public's lack of understanding and knowledge of biotechnology applications and benefits. As a result, the Public Understanding of Biotechnology Programme was initiated to provide South Africans with information, enabling them to participate meaningfully in debates about biotechnology and to make informed decisions in this regard.

In addition, the implementation of the NBS saw the development of the National Bioinformatics Network at eight universities, investing in technology R&D, infrastructure and teaching.

The results of biotechnology investments have long lead times, sometimes up to 15 years. However, some success stories resulting from the investments and interventions made by the biotechnology institutions are already being reported. The goal is to expand the country's biotechnology platform and develop a bio-economy base.

International collaboration is important in this regard, and since 2007, the world's third component of the International Centre for Genetic Engineering and Biotechnology (ICGEB) has been hosted in Cape Town.

The ICGEB is a centre of excellence promoted by the United Nations Industrial Development Organisation. In 2009, the Cape Town component focused its research and training activities primarily on infectious diseases (HIV and AIDS, malaria, TB and hepatitis), as well as on plant-biotechnology research aimed at improving staple crops.

In a major boost for South Africa's ambitions to host the Square Kilometre Array (SKA), a construction team installed the first antenna of the Karoo Array Telescope, a seven-dish prototype of the SKA, near Carnarvon in the Northern Cape, in July 2009.

The SKA is a planned future-generation international radio telescope that will enable astronomers to probe the early evolution of the galaxy. It will comprise about 3 000 antennae that, put together, will cover a square kilometre.

South Africa is competing against Australia to be selected as the preferred site for the SKA; the two countries having beaten bids from Argentina and China to make the SKA shortlist.

The International SKA Steering Committee in the Netherlands is expected to make a final decision on the host country in 2012.



Astronomy

The Astronomy Geographic Advantage Act, 2007 (Act 21 of 2007), provides for the preservation and protection of areas in South Africa that are uniquely suited to optical and radio astronomy; and intergovernmental cooperation and public consultation on matters concerning nationally significant astronomy advantage areas.

South Africa continues to promote high-technology investment to ensure that local researchers and students are able to participate in international astronomy. A key result was the launch of the Southern African Large Telescope (Salt) in November 2005, in Sutherland in the Northern Cape.

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

South Africa has been shortlisted, along with Australia, as a possible host for the biggest radio telescope ever built, the Square Kilometre Array (SKA). A final decision in this regard is expected in 2011. The SKA will be the only instrument able to answer the most basic questions of the origin of the universe and the birth and evolution of stars and galaxies. It will be used to investigate the origin of magnetism in the universe and will be the most powerful instrument ever to search for extraterrestrial intelligence.

South Africa has developed a partnership with eight other countries to locate SKA stations in each country. The countries are Botswana, Ghana, Kenya, Madagascar, Mauritius, Mozambique, Namibia and Zambia. The report indicated that the only two remaining bidding countries are South

Africa and Australia. The SKA initiative will benefit information and communications technology (ICT) infrastructure development and postgraduate student training in engineering, ICT and astronomy. The bid will cost R1,6 billion over a three-year period.

In October 2009, Cabinet approved the establishment of an interministerial committee to oversee the preparations to award the bid for the SKA.

The country has also assembled a team to build the Karoo Array Telescope, which is working with researchers in the UK, the Netherlands, Australia and the USA to develop digital signal processing for the telescope, and software and innovative telescope antennae, using composites.

There is also the MeerKAT radio telescope, which is both an SKA demonstrator telescope and an indigenous initiative to build a hi-tech centimetre-wave radio telescope, and which is expected to be a world leader for many years.

South African scientists and engineers began the design, development and construction of MeerKAT in 2005, in collaboration with the universities of Cambridge, Oxford, Manchester and California, as well as Caltech, the Netherlands Institute for Radio Astronomy and others.

MeerKAT will be completed and in service by late 2012 and will consist of up to 80 12-metre antennae.

The SKA and MeerKAT projects are important for developing high-level skills and expertise in South Africa, and have provided funding for graduate-study associated with these projects.

This programme is being extended to South Africa's partners in the SKA bid – Botswana, Ghana, Kenya, Madagascar, Mauritius, Mozambique and Namibia.

Space science

South Africa's 10-Year Innovation Plan identifies space S&T as one of five priority areas.

The National Space Agency Act, 2008 aims to promote the peaceful use of outer space; foster research in astronomy, Earth observation, communications, navigation and space physics; foster international cooperation in space-related activities; and advance scientific, engineering and technological competencies through human-capital development and outreach programmes.

The agency will facilitate the development of space missions; develop technology platforms; and acquire, assimilate and disseminate space-satellite data for any organ of state. It will also implement the National Space Strategy, which

was approved by Cabinet in December 2008, to stimulate the capability to place South Africa among the leading nations in the innovative use of space S&T.

In September 2009, the R26-million low-Earth orbiting satellite, SumbandilaSat, was successfully launched into space. The 81-km micro-satellite blasted into space from Baikonour in Kazakhstan, aboard a Russian Soyuz rocket.

The satellite is the result of a three-year programme commissioned by the Department of Science and Technology and developed by the University of Stellenbosch's engineering faculty and its commercial spin-out Sun Space.

The satellite carries a high-resolution camera that produces images for use in monitoring agriculture, mapping infrastructure and land use, tracking population movement and measuring dams' water levels. Data will be streamed to the CSIR's Satellite Applications Centre (SAC) at Hartebeesthoek, near Pretoria, for analysis and policy-development purposes.

The SAC will carry out command and communications functions by tracking the satellite using a large dish antenna. In addition to the camera, the satellite carries a secondary communications payload from the Department of Communications and experimental payloads for the scientific community in the areas of low-frequency radio waves, radiation, software-defined radio, forced vibrating string and radio-amateur transponders.

Nanotechnology

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

The South African industry and researchers have been involved in nanotechnology and the practical application of nanoscience for several years (for example, Sasol's chemical processing by catalysis), but new generations of emerging nanotechnology-based products require that South Africa develops its ability to derive more benefits from global advances in this area.

The National Nanotechnology Strategy, launched in 2006, recognises the needs of local industry and focuses on the essential building

blocks of nanoscience, namely synthesis, characterisation and fabrication.

The strategy positions South Africa as a global player in this emerging area and seeks to strengthen government's integrated development focus by:

- supporting long-term nanoscience research that will lead to a fundamental understanding of the design, synthesis, characterisation, modelling and fabrication of nanomaterial
- supporting the creation of new and novel devices for application in various areas
- developing the required human-capital and supporting infrastructure

The strategy is expected to stimulate new developments in technology missions, such as

- advanced material for advanced manufacturing
- nanobiomaterial for biotechnology
- precious metal-based nanoparticles for resource-based industries
- advanced material for ICTs.

The strategy is aimed at increasing the number of nanotechnology characterisation centres in South Africa. In 2007, National Treasury allocated R450 million to implement the strategy over three years.

The country's first two nanotechnology innovation centres, based at Mintek and the CSIR, were established in 2007. These centres play a central role in implementing the Nanotechnology Strategy and are expected to provide a platform for world-class research in the fields of nanoscience and nanotechnology.

Information and communications technology

South Africa devotes 10,5% of its R&D expenditure to ICT. South African researchers have the advantage of using massive computing power in their quest for new knowledge and applications.

The Centre for High-Performance Computing (CHPC) in Cape Town was the first of its kind in South Africa. Hosted by the University of Cape Town 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-Performance Computing Facility was officially launched by the Department of Science and Technology at the North West University's Potchefstroom Campus in October 2009.

The facility was established in response to the ongoing demand for computing power, particularly in the field of natural-sciences research. It will enhance the university's capacity to deliver research excellence, ensuring that it remains one of the country's top research institutions.

The facility opened its doors at the beginning of 2009, and by October almost 1 700 research assignments were completed.

The field of high-performance computing is at the cutting edge of computing technology, incorporating the areas of processing, networking, storage and visualisation. It is a critical enabler in numerous applications that advance the frontiers of science.



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.

To maximise the benefit and use of this infrastructure, the research communities in South Africa are self-assembled into 10 special-interest groups, and the CHPC adds significant computational power to accelerate the research agenda of these groups.

The CHPC and the South African Research Network are the backbone of an emerging cyberinfrastructure in South Africa that aims to support research initiated in other elements of the country's S&T infrastructure, such as the SKA, the National Bioinformatics Network and the Global Earth Observation System of Systems (GEOSS).

The GEOSS aims to enable globally coordinated Earth observations across a number of domains, to provide better and more reliable data in areas of benefit to society, including agriculture, weather, climate, water, disasters, health, energy, biodiversity and ecosystems.

International science and technology cooperation

By 2009, the strategy to use southern Africa's local (geographical) advantages and efforts to attract large international science-based investments was paying off.

Examples of these investments included the construction of the High-Energy Stereoscopic System observatory in neighbouring Namibia and the Salt in Sutherland in the Northern Cape,

as well as winning the bid to host the European Developing Countries Clinical Trials Partnership.

International breakthroughs included South Africa's leading role in the European Union's Framework Programme, and in implementing Africa's Consolidated S&T Plan of Action.

In 2009, South Africa was involved in developing an S&T platform in the subregion through the Southern African Development Community (SADC) Ministers' Council on S&T, which was developing a SADC protocol to guide the implementation of the subregional S&T plan.

The Department of Science and Technology's flagship project is developing a high-speed broadband network in the region.

The UbuntuNet Project is set to link the South African National Research Network to Europe, via the Geant connection, to give South Africa and its research community a high-speed network.

The first phase of implementing this network began with funding of R178 million over the Medium Term Expenditure Framework.

The country has successfully leveraged support for human-capital development through international S&T agreements. This has resulted in jointly funded projects with 16 countries in areas such as agriculture, manufacturing and biotechnology.

South Africa's role at the forefront of Nepad is, to a significant extent, based on its ability to deploy scientific knowledge and technological solutions on the continent.

The International Council for Science (ICSU) launched a regional office for Africa in Pretoria in 2005. South Africa hosts the office at the premises of the NRF.

The country leads the international process to establish the GEOSS, participated in developing the 10-year implementation plan and was elected co-chair of the GEOSS.

South Africa hosts the Nepad focal points such as the African Laser Centre (ALC), the African Institute for Mathematical Sciences (Aims) and the biosciences initiatives.

Every two years, the ALC hosts summer schools co-funded by the United States of America (USA)-based National Science Foundation, and Aims is establishing a network of institutes on the rest of the continent.

South-South cooperation has been strengthened and enhanced by fostering partnerships with the countries of the South, and in particular African countries. South Africa is spearheading a number of bids to host significant international

facilities in Africa and is doing so in collaboration with its partner African countries.

National Research Foundation

The NRF is the intermediary agency between the policies and strategies of government and those institutions that perform research.

Unlike other science councils whose role is research performance, the NRF primarily fulfils an agency role, with a smaller portion of its activity allocated to research performance through the 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.

Funding from the NRF is largely directed towards academic research, developing high-level HR and supporting the nation's 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 black 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 and innovation
- 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.

In 2008, the NRF Board approved the NRF Strategic Plan, NRF Vision 2015. Its objectives include:

- promoting internationally competitive research as a 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 National Research Foundation's role in the National System of Innovation

The NRF performs a dual function in the NSI: as an agency that steers the system according to strategic policies, and as a research performer. These are some of the areas it is involved in:

- 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 those who have talent and potential from an early age, and which support 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 that resides in the NRF, provides the infrastructure that forms the foundation of nanotechnology flagship research projects.
- The Department of Labour, together with the departments of basic education and higher education and training and the Department of Science and Technology, was responsible for ensuring that training in scarce skills takes place, especially in the fields of S&T. To deliver on this objective, the Department of Labour makes available funds for bursaries and scholarships from the National Skills Fund and 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 intermediary between government strategies, research institutions and researchers. Its key objectives are to ensure appropriately qualified people and high-level infrastructure to produce the knowledge that makes South Africa a global competitor.

It disburses funding from various sources, such as the funds:

- allocated to the NRF via the Parliamentary core grant
- received from various government departments.

These ring-fenced and contract funds are disbursed according to strict criteria laid down by the respective sponsors.

Risa's investment in knowledge, people and infrastructure focuses on seven areas:

- established researchers
- human-capital development and unrated researchers
- strategic knowledge fields
- strategic platforms (including research at the national research facilities)
- international initiatives
- applied and industrial research and innovation
- research on community engagement in SET.

South African Agency for Science and Technology Advancement

Saasta supports all science-advancement interventions across the NRF in the following ways:

- education-related programmes (preparing future scientists and innovators)
- SET awareness platforms (engaging the public with the phenomena of SET)
- science communication (communicating the advances of S&T to the public).

Saasta is integrally involved in promoting science at school level and creating public awareness. These efforts are designed to translate into a broader base from which tertiary level institutions can draw HR.

As such, it helps to grow the size and enhance the quality of the feeder system that can benefit from NRF support at postgraduate level.

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 (SAAO)

The SAAO performs fundamental research in astronomy and astrophysics at a national and international level. It is the national facility for optical and infrared astronomy in South Africa and is also responsible for managing the operations of the Salt.

Hartebeesthoek Radio Astronomy Observatory (HartRAO)

The HartRAO was 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.

Hermanus Magnetic Observatory (HMO)

The HMO is part of a worldwide network of magnetic observatories that monitor and model variations of the Earth's magnetic field. It also performs fundamental and applied space physics research, and provides geomagnetic field-related services on a commercial basis.

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.

South African Environmental Observation Network (Saeon)

The Saeon establishes and maintains nodes (environmental observatories, 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 is the national facility for research in terrestrial biodiversity and an active participant in terrestrial biodiversity research. It houses one of the largest animal collections in the world, operates three biodiversity centres and has almost 8 000 hectares available at different locations for its respective activities.

iThemba Laboratory for Accelerator-Based Sciences (Labs)

The iThemba Labs provides advanced, viable, multidisciplinary facilities for training, research and services in the fields of sub-atomic nuclear science and applied radiation medicine.

Special initiatives

The following projects, selected from a range of current initiatives, reflect some of the activities in which the NRF is involved:

South African PhD Project

The South Africa PhD Project is focused on attracting new doctoral candidates and providing them and current doctoral students with information and peer- and mentor-support mechanisms.

The NRF has embarked on this initiative in partnership with the Department of Science and Technology with the vision of increasing the number of doctoral graduates ten-fold by 2025.

International science activities

It is the NRF's task to build the capacity of South African researchers so that they can become leaders in the international research context.

To achieve this, the NRF creates opportunities for constructive international collaboration with other researchers so that knowledge can be generated, transferred and exchanged.

Some of the initiatives that aim to fulfil this goal were:

- providing administrative support to the ICSU
- participating in special research projects as part of International Polar Year, 2009
- leading programmes in the African region for the International Year of Astronomy, 2009

South African architect Shaun Killa, who is the brain behind the world's first wind-powered building, was lauded along with several international engineering minds in New York, in June 2009.

The University of Cape Town graduate, then head designer of Atkins Middle East, became the face of sustainable building design for his bold new approach to energy-saving in 2009. Killa's approach gave birth to the internationally renowned Bahrain World Trade Centre.

At 240 metres high, the twin-tower complex has been hailed as the largest integration of electricity-generating turbines in building design.

It uses wind power to reduce energy consumption and has three 275 kilowatt (kw) turbines that produce a total of 700 kw.



- negotiating inter-agency agreements with science councils in, among other countries, India, the USA, the Czech Republic and the United Kingdom.
- establishing binational S&T agreements with a variety of regions and countries, including Algeria, China, France, Hungary, Kenya, Japan, Mozambique, Namibia, Nigeria, Norway, Poland, the Republic of Korea, Spain, Sweden, Switzerland, and The Flanders.

National Research Foundation rating system

Since research excellence is the cornerstone of the NRF, evaluation features prominently across all its programmes and capacity-building initiatives.

This positions the organisation as the guardian of a rating system that accurately and fairly defines world-class researchers, whatever their fields.

The system initially provided for A, B and C categories but those have been expanded to include categories for young researchers, those with demonstrated potential as well as late entrants into the research system.

To qualify for an "A" rating, researchers must be "unequivocally recognised by their peers as leading international scholars in their field", while a P-rating is assigned to younger researchers who, on the basis of exceptional potential demonstrated in their published doctoral work and/or their research outputs, are considered likely to become future leaders in their field.

In 2008, 15 new A-rated scientists were honoured and six P-rated young scientists were recognised.

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 to support technology development in its precompetitive phase.

Agricultural Research Council (ARC)

The ARC is a statutory body established in terms of the Agricultural Research Act, 1990 (Act 86 of 1990). It comprises research institutes that were previously part of the Department of Agriculture, the oldest of which dates back to 1902.

As the principal agricultural research institution in South Africa, the ARC is committed to agricultural research, technology development and

technology transfer within the macro-framework of the agricultural sector, thereby contributing to the quality of life of South Africans.

The ARC's research goals are aligned with the objectives of the Strategic Plan for South African Agriculture.

The ARC's research activities address major government priorities, namely integrated rural development, natural-resource management, job creation, regional integration, urban renewal, HR development, crime prevention, farmer settlement, support-service improvement, infrastructure development, food security, and trade development and support.

The ARC comprises the following business units:

- Natural Resource and Engineering Business Division
 - Institute for Soil, Climate and Water
 - Institute for Agricultural Engineering
 - Plant Protection Research Institute
- Grain and Industrial Crops
 - Grain Crops Institute
 - Small Grain Institute
 - Institute for Industrial Crops
- Horticulture
 - Institute for Tropical and Subtropical Crops
 - Roodeplaat Vegetable and Ornamental Plant Institute
 - Infruitec/Nietvoorbij
- Livestock
 - Onderstepoort Veterinary Institute
 - Livestock Business Division: Animal Production.

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

The CSIR is one of the leading S&T, R&D and implementation organisations in Africa. The CSIR's main site is in Pretoria, and the organisation is represented in other provinces of South Africa through regional offices.

The CSIR transfers the knowledge generated through research activities by means of technology and skilled people. The generation and

application of knowledge reside at the core of the CSIR.

These take place in domains such as biosciences; the built environment; defence, peace, safety and security; materials science and manufacturing; modelling and digital science; and natural resources and the environment.

Emerging research areas

These are areas of science, explored by the CSIR, that could be unique to local circumstances or successful internationally and need to be established for local competitiveness. Examples include nanotechnology, synthetic biology and mobile autonomous intelligent systems.

National research centres

The CSIR houses specialist facilities of strategic importance for African science. These include ICTs, and laser and space-related technology.

Research and development outcomes

Activities include intellectual property (IP) management, technology transfer (for commercial gain as well as for social good), knowledge dissemination and impact assessment.

Consulting and analytical services

The CSIR has a group of facilities that manages standard technology-based services. The experts in this group use the value of CSIR knowledge-application activities by providing specialised consulting, analysis and testing services to address the clients' needs.

Services include forensic fire investigations, food and beverage analysis, environmental consulting and laboratory services, engineering forensics, wire-rope testing, mechanical testing, fires and explosion tests, self-contained self-rescuer testing, sports technology and analysis, and project management.

Supporting national imperatives

South Africa's national imperatives and global challenges provide the macro-strategic framework within which the CSIR conducts its research.

In an effort to contribute to placing Africa on a path of sustainable growth and development, the organisation supports and participates in Nepal.

The CSIR contributes to the national programme of development by:

- building and transforming human capital
- strengthening the SET base and performing relevant R&D

- transferring technology and skilled human capital.

Operations

The CSIR receives an annual grant from Parliament, through the Department of Science and Technology, which accounts for about 40% of its total income.

The remainder is generated from research contracts with government departments at national, provincial and municipal levels; the private sector; and research-funding agencies in South Africa and abroad. Additional income is derived from royalties, licences and dividends from IP management and commercial companies created by the CSIR.

The parliamentary grant is focused on the knowledge base and facilities in the CSIR to ensure that these stay at the leading edge of technological development. It is invested in developing new areas of expertise, undertaking “pre-competitive” research too risky for the private sector to fund and for training young researchers.

Mintek

South Africa’s national mineral-research organisation, Mintek, 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, consultation and innovative products to clients worldwide.

Mintek is an autonomous statutory organisation that reports to the Minister of Mineral Resources. About 30% of the annual budget is funded by the State Science Vote, with the balance provided by contract R&D, sales of services and products, technology-licensing agreements and joint-venture operating companies.

Mintek’s objectives are to research, develop and transfer to industry novel and improved technologies to optimise processing, extracting and refining and using minerals and mineral products to:

- enhance the competitiveness of South Africa’s minerals industry in the global market
- assist local mining and engineering companies to expand internationally
- promote job creation, economic growth and regional development.

Mintek’s activities include:

- providing essential services (information, consulting and experimental)

- increasing the competitiveness of the industry by developing appropriate technology to cut costs and improve and optimise recoveries
- developing breakthrough process technologies and novel uses for metals and their products
- marketing its commercial products and technologies to industry
- establishing strategic partnerships and joint ventures
- participating in regional development initiatives and SADC activities and projects
- maintaining and expanding international scientific links
- developing the HR potential of the region through education and training activities.

Mintek offers a complete range of process-development services, from preliminary bench-scale investigations to large-scale piloting and integrated flowsheet development in support of bankable feasibility studies. Engineering design, plant construction and commissioning are conducted in conjunction with international partners.

Comprehensive laboratory and piloting facilities for sample preparation, milling, flotation, physical separation, smelting, leaching, pressure leaching, and metal recovery and purification are supported by internationally accredited analytical laboratory and mineralogical services.

Mintek’s R&D activities are focused particularly on mineral commodities that are important to the South African economy:

- Gold-improving technologies, such as biotechnology and ion-exchange processes are developed and introduced to simplify processing and increase recoveries, particularly from ores that are difficult to treat. A major joint venture with industry and other research groups is exploring new industrial uses of gold in the fields of catalysis, nanotechnology and biomedicine.
- Platinum-group metals’ (PGMs) R&D is aimed at increasing the cost-effectiveness of PGM production and stimulating industrial demand for these metals. In association with an industrial partner, Mintek is developing the ConRoast process for treating PGM concentrates that cannot be smelted directly using conventional technology.
- Ferrous-metal products and technical services are developed to increase the cost-effectiveness of ferro-alloy production, as well as stainless steels and other alloys with improved properties.
- Mintek has conducted a large amount of work for non-ferrous metals, such as new copper,

nickel and cobalt, through projects in southern and central Africa. Processes are also developed for aluminium, lead, magnesium and zinc. The major emphasis is on the introduction of cleaner technologies.

- R&D includes the beneficiation and processing of industrial minerals, including commodities such as heavy mineral, chromite, iron and manganese ores, andalusite, phosphates, fluorite and diamonds.
- With the upswing in the uranium market, Mintek has re-established itself as one of the foremost uranium laboratories in the country, and has played a significant role in developing and optimising several new projects on the African continent.

Minerals policy and development

Mintek conducts surveys, evaluations and commodity and market studies to support initiatives by governmental, international, regional or industry associations. It also identifies and evaluates potential development projects, assesses and provides technology, and conducts feasibility studies.

The organisation cooperates with industry and other research institutions and academia to

maintain and enhance the mineral sector's contribution to society, by providing strategic direction and procedures that promote value addition and sustainable development in the mining industry.

Mintek is frequently called upon to support strategy and policy issues at all levels in South Africa, including participation in Nepad and the African Mining Partnership, through research into Black Economic Empowerment-development issues around mining and minerals.

Mintek is growing its capacity to lead and support multiple initiatives in small-scale mining and beneficiation. It is well positioned to lead projects that will benefit economies on the African continent and support government initiatives to create employment in mining, manufacturing and agriculture at local and rural levels.

Environment

Mintek continues to focus on developing environmentally responsible technologies for the recovery and recycling of metals from metallurgical residues. A major programme is in place to monitor cyanide species in various locations around gold plants, from both an environmental and a processing point of view. A new cross-disciplinary effort is focused on increasing the energy and water efficiency of mineral-processing operations. Mintek's environmental-management system is certified as meeting the requirements of the International Organisation for Standardisation 14001.

Education

The development of appropriate HR is crucial for the long-term sustainability of the minerals industry. Mintek's education and training initiatives focus on developing and training South Africans from historically disadvantaged communities as technicians, technologists and engineers. Training programmes include:

- artisanal and small-scale mining training
- jewellery-manufacturing training
- upgrading Mathematics and Science skills
- science promotion through participation in various SET initiatives (sponsored by the departments of science and technology and mineral resources), corporate events, university open days and the Minquiz national schools' science competition
- corporate social investment and responsibility through Mintek's Adopt-a-School Programme and Grade 11 and 12 Learner Programme
- undergraduate and postgraduate bursary schemes

In November 2009, scientists at the University of the Witwatersrand announced the discovery of a new species of dinosaur. Fossils from two aardonyx were found, one which was seven metres long and the other nine. They are an estimated 195 million years old, dating from the early Jurassic period, and were herbivores.

Due to their underdeveloped bone structure, it is believed that the fossils recovered were from juveniles between seven and 10 years old. An adult aardonyx may have been larger than those found.

The dinosaurs shared traits of evolutionary precursors with the sauropods, which were plant eaters that walked on four legs and dominated the Jurassic period. Aardonyx, by contrast, walked on two legs but is believed to have occasionally also used its forelegs to walk. However, like sauropods living at the time, aardonyx grazed by stripping vegetation from branches with its small teeth.

The aardonyx were found on a farm in the Senekal district of Free State. It was one of three new dinosaur species found in the area. Also found was a single tooth from a carnivorous dinosaur near the aardonyx's remains. Because of the number of dinosaurs found in the area, it is likely that the area was the location of a "paleontological oasis", a lush, green spot amid the arid floodplain, which was pre-historic South Africa.



- in-training programmes for recently qualified engineers and technicians
- specialised advanced technical programmes.

Promoting industrial growth

Mintek is promoting a number of major new industrial projects based on mineral beneficiation, using existing and newly developed technologies. These include the recovery of PGMs from metallurgical waste material, ferro-nickel production and the establishment of local magnesium and titanium industries.

Human Sciences Research Council (HSRC)

South Africa's statutory research agency, the HSRC, conducts research that generates critical and independent knowledge, relative to all aspects of human and social development.

Poverty alleviation and public policy development and implementation are central to all its research activities. Its research extends beyond South African borders through projects and collaborations in other African countries and abroad.

As a national public entity, the HSRC adheres to best-practice requirements in relation to its corporate governance as well as financial and performance reporting. The HSRC reports annually to Parliament.

The HSRC is committed to making a difference in the quality of life of all South Africans and is often commissioned to undertake large-scale research on behalf of government departments at national, regional and local levels. The organisation also serves the research needs of parastatal organisations, the private sector and local and international development agencies to track service delivery, evaluate performance and measure the efficacy of interventions.

The HSRC's collaborative approach to research provides a platform for interaction with research experts in South Africa, elsewhere in Africa, and internationally. The organisation proactively disseminates its research findings in peer-reviewed and other publications, and through seminars, invited lectures and media briefings.

Functioning as a knowledge hub, the HSRC contributes to bridging the gap that so often exists between research, policy and action.

The HSRC is a non-partisan organisation that provides critical information to different role players, whether in policy development, media analysis, advocacy or in debates. It aims to be an instrument for providing independent information, free from political, religious and/or racial bias. The

The South African HIV and AIDS Research and Innovation Platform (Sharp) was launched in July 2009.



Sharp is one of many South African government initiatives to fight HIV and AIDS.

Sharp is intended to provide a platform for evidence-based solutions that will contribute to the HIV and AIDS and Sexually Transmitted Infections Strategic Plan for South Africa. Sharp aims to do this through scientific and technological advancement to support all aspects of the fight against HIV and AIDS, from the development of new drugs and phytotherapies, to diagnostic tests and vaccines.

The Department of Science and Technology has established Sharp as part of carrying out its mandate to ensure a better life for all South Africans through the use of science and technology. Stakeholders in both the public and private sectors were consulted during the establishment process to determine priority areas in the HIV and AIDS research field.

The department has committed R45 million to Sharp over a three-year period. It will also call on other partners to join in funding Sharp.

HSRC generates scientific knowledge through its research and analytical work in the social and human sciences.

Research focus

Research capabilities have been aligned into the following interdisciplinary, problem-orientated, research programmes:

- Education, Science and Skills Development
- Child, Youth and Family Development
- Social Aspects of HIV and AIDS and Health
- Democracy and Governance.

The former national initiatives have now become centres of excellence. Additionally, a former research programme, Urban, Rural and Economic Development has been unbundled to become a centre for service delivery.

Centres of excellence at the HSRC include the:

- Centre for Poverty, Employment and Growth
- Centre for Service Delivery
- Centre for Education Quality Improvement.

In addition, a number of cross-cutting research initiatives support the work of the HSRC as a whole, its research programmes, as well as external stakeholders.

Cross-cutting research units include the:

- Research Network (the Social Aspects of AIDS Research Alliance)
- Knowledge Systems
- Policy Analysis and Capacity Enhancement, which consists of:

The three-yearly General Conference of the Academy of Sciences for the Developing World (TWAS), themed *Science for Africa's Development*, took place in Durban in October 2009.

Hosted by the Department of Science and Technology and the Academy of Science of South Africa, an entity of the department, the conference was intended to mobilise the scientific community to generate collective, evidence-based solutions to national problems, and to play a critical role in global endeavours to promote science and technology.

TWAS, an autonomous international body, was founded in Italy in 1983 by a distinguished group of scientists from the South. Its aim is to promote scientific excellence and capacity in the region for science-based sustainable development.



- Capacity Development
- Gender
- Policy Analysis
- Centre for Africa's Social Progress.

The Policy Analysis Unit has a dual mandate. The first is to serve as a think-tank and provide a platform for public discourse and critical social issues. The second is to pursue time-limited, multi-year analyses into specific priority areas, namely poverty reduction, employment, quality education, HIV and AIDS and service delivery. The work of the unit is centred upon various cross-roads between these policy issues and heuristic parameters drawn from the National HR Development Strategy.

The support functions of the HSRC are primarily intended to support its core activity, namely research, while also ensuring that the organisation complies with regulatory requirements.

Medical Research Council (MRC)

The MRC's mission is to improve the nation's health and quality of life through promoting and conducting relevant and responsible health research.

Although the MRC is an autonomous body, it reports to the Department of Health and receives 60% of its budget from the Department of Science and Technology. Its head office is situated in Cape Town, with provincial offices in Pretoria and Durban.

The MRC's research activities are aligned with the health priorities of the nation, the national S&T imperatives and the health priorities defined by the Department of Health. Activities are grouped into the following programmes:

- National Programme for Research in Molecules to Disease
- National Programme for Health Systems and Policy Research
- National Programme for Infection and Immunity Research
- National Programme for Non-Communicable Disease Research
- National Programme for Environment and Development Research
- National Programme for Women and Child Health Research
- South African National Health Knowledge Network.

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 main functions of the CGS are:

- documenting the surface of the Earth within the borders of South Africa; compiling geological, geophysical, geochemical and other geoscientific information; and publishing this information in the form of maps and documents
- conducting geoscientific research into, among other things, rocks, minerals, ores and fossils in South Africa and publishing research results in national and international journals
- collecting and conserving all geoscientific information and data on South Africa in national collections and electronic databases
- supplying geoscientific services and advice to the national and provincial governments and ensuring informed decisions regarding the optimal and efficient use of the Earth's surface.

The objectives of the CGS are to:

- minimise the geological and geoscientific investment risk for national and international entrepreneurs in the South African mining sector (the quality of available geological information – known as the “geological risk grading” – contributes to about 61% of the investment risk in any country)

- supply the country with basic geoscience data to establish a safe, cost-effective physical infrastructure
- supply basic knowledge to ensure safe, cost-effective and environmentally acceptable urbanisation and housing development
- carry out research into raw material needed to clothe, transport, feed and provide shelter for the nation.

To accomplish these functions and objectives, the CGS maintains a specialised workforce, consisting of Earth scientists supplemented by technical, support and administrative staff at its headquarters in Pretoria, and at branch offices in the Western Cape, Northern Cape, Limpopo, KwaZulu-Natal and the Eastern Cape.

The CGS maintains the following national institutions:

- The National Geoscience Library in Pretoria is probably the most comprehensive geoscience library in Africa. It includes the Map Library, which contains a collection of South African and African geoscience maps.
- The National Core Library contains a representative stratigraphic-borehole core collection, representing most of the lithological units located within the borders of South Africa. This collection is housed at Donkerhoek, east of Pretoria.
- The Geoscience Museum, in the Transvaal Museum in Pretoria, exhibits rocks and minerals, catering for the Earth-science education of the public, especially schoolchildren.

An extensive laboratory at the CGS head office uses various specialised techniques to analyse rock and soil samples.

Geoscience information and services provided by the CGS are particularly important for the sustainable development of the country. In South Africa's arid regions, the management of groundwater resources (both the quantity and quality thereof) is aimed at providing enough clean water to communities. In addition, the CGS has established the Environmental Geoscience Unit to provide services in this highly competitive and very important field.

Although South Africa is situated on a relatively stable part of the Earth's crust, the CGS maintains a seismic network for recording such events within the national borders and coastal waters off South Africa's coastline. This information is available to interested parties and helps mitigate the problems associated with mining-related seismic events.

The CGS is a world leader in the domain of geophysical surveys, using a detection system deployed on light aircraft. This significantly reduces the cost of very high-resolution geophysical data for mineral exploration. An aircraft (a Cessna Caravan 208B) and a helicopter carry large sensors, increasing the CGS' capability to conduct high-resolution geophysical surveys.

The CGS leads an initiative by the Department of Mineral Resources to assist upcoming mining entrepreneurs, particularly those from historically disadvantaged groups, to exploit South Africa's mineral resources in a cost-effective and environmentally friendly way.

Because the CGS plays a leading role in the SADC, several geoscience publications covering the region have been produced, describing heavy mineral sand, diamond, gold, copper and cobalt, bauxite and dimension-stone deposits in the region. A seismic hazard map of the region, a lithostratigraphic table comparing the geological formations in the region, and maps of the Kalahari Basin have also been produced.

In addition to its national responsibilities, the CGS is also active internationally, mainly in Africa. Geological and metallogenic maps of, among other countries, Angola, the Democratic Republic of Congo, Mozambique, Gabon and Morocco have been produced.

South African Bureau of Standards (SABS)

The SABS was established in terms of the Standards Act, 1945 (Act 24 of 1945), and operates in terms of the latest edition 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' vision is to be the trusted third party that offers uncompromised value-added standardisation services.

Its mission is to protect the integrity of the South African market and the end consumer, create a competitive advantage for the South African industry and improve market access locally and internationally.

The SABS' core objectives are to:

- promote standardisation in industry and commerce
- prepare, modify or amend specifications and codes of practice
- undertake educational work in connection with standardisation

- assist government departments, public bodies, and provincial and local authorities in the preparation of any specification or code of practice they require
- provide input and advice to government departments in the areas of standardisation and conformity assessment
- cooperate with industry, government departments, provincial and local authorities and other public bodies or individuals to ensure the standardisation of products or services
- collaborate with relevant international organisations to protect and advance South Africa's interests.

Other objectives of the SABS include:

- controlling the use of standardisation and distinctive marks
- providing conformity assessment services to industry and the State, such as:
 - laboratory-testing services
 - product certification
 - system certification
 - consignment inspections
- issuing relevant SABS marks for approved products as proof that their manufacturers have complied with required specifications
- providing facilities for testing and calibration of precision instruments, gauges and scientific apparatus
- providing facilities for examination and testing of products and any material or substances from which they are manufactured.

The SABS provides products and services in standards, testing, certification, training and design promotion in the following sectors:

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

The SABS' range of services cover quality, risk, environmental, occupational health and safety, and product-specific certification. The SABS Training Centre offers outcome-based training in all management-system standards.

Other scientific and research organisations and structures

Biotechnology Partnership for Africa's Development (Biopad)

Biopad is a biotechnology regional innovation centre established by the Department of Science and Technology. The centre, initiated in 2002,

aims to boost biotechnology development in the region. The core objective is to implement South Africa's NBS.

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 Technology conducts most of its fuel- and chemical-related R&D at Sasolburg in the Free State. It also maintains R&D programmes at external centres of excellence, including St Andrews University in Scotland, Twente University in the Netherlands and the University of Cape Town in South Africa.

Sasol Polymers operates a polymer technology centre near Johannesburg, and Sasol Nitro and Sasol Wax maintain R&D programmes in South Africa and Germany, respectively.

ArcelorMittal

ArcelorMittal is the world's number one steel company, with over 320 000 employees in more than 60 countries. It led the consolidation of the world steel industry and today ranks as a truly global steel-maker, with an industrial presence in 27 countries. ArcelorMittal is the 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)

With 265 laboratories nationwide, the NHLS provides diagnostic services to the more than 5 000 clinical facilities around the country.

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 is 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. The tasks of the Ieri 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.

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 subcommittee 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

The Chief Directorate: Energy of the Department of Energy manages a policy-directed research programme. This includes transport energy, renewable energy, energy for developing areas, coal, electricity, energy efficiency, energy economy and integrated energy-policy formulation.

Agricultural research

Agricultural research is conducted by the ARC, several universities and various private-sector

In June 2009, South African-born scientist, Peter Jones, received the United States of America's highest cancer research award for pioneering an entire new field of science, called epigenetic therapy.

About 358 patients in 15 countries were involved in the international trial, which found that those receiving the therapy survived an average of 9,4 months longer than those on conventional treatment, with a two-year survival rate that was nearly doubled.

Instead of killing cancer cells with chemotherapy or radiation, the new form of therapy activates dormant genes in the affected cells and instructs them to become healthy again.

organisations. 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 agree 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 innovative 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 will face the limited water resources 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 and, in so doing, 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
- non-governmental organisations (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.

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.

Environmental research

The Chief Directorate: Environmental Management of the Department of Environmental Affairs annually finances several research and monitoring programmes.

The programmes comprise 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).

The implementation of NiNjo, the new forecasting workstation, will be a major step towards improving the quality of forecasting products and services. The SAWS will be the first national meteorological service in the southern hemisphere to have access to this state-of-the-art technology, which presents product development

and research opportunities for South Africa's forecasters and researchers.

Among other activities, the SAWS runs the Global Atmospheric Watch Programme, which measures and monitors GHG 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.

Some 170 projects are approved annually, and global issues such as climate change and biological diversity are also included. The sustainable use of natural resources is a priority area, resulting in an increase in projects relying on sociology and the humanities. The NRF also supports a range of environmental research network organisations, such as the Arid Zone Ecology Forum, the Fynbos Forum, the Indigenous Plant-Use Forum and the Savanna Ecology Forum.

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 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.

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.

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 can make use of various overseas developments.

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)
- 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 SA (long-distance transmission of information and lighting protection).

Acknowledgements

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