

# Science and Technology



The National Development Plan (NDP) identifies the important role of science, technology and innovation in achieving the country's longer-term vision.

The construction of the 64-dish MeerKat satellite dishes – a precursor of the Square Kilometre Array (SKA) project – commenced in May 2013.

Government has injected R2 billion into the SKA project. The MeerKat is expected to be completed by 2016. In March 2013, South Africa officially launched the first of 64 antennas that will make up the MeerKAT radio telescope. The MeerKAT Karoo Array Processor Building, a cutting-edge data centre for the MeerKAT that has been built in an underground bunker at the Karoo observatory site, was officially opened at the same time.

The MeerKAT will be one of the precursors to the SKA telescope, and will later be incorporated into the mid-frequency component of SKA Phase 1 when that instrument is constructed. The SKA will be the world's largest radio telescope, located in Australia and South Africa but shared by astronomers around the globe.

Standing 19,5 m tall and weighing 42t, the new MeerKAT antenna towers above the antennas of the nearby KAT-7 instrument, an engineering prototype for the MeerKAT, which is now routinely used for scientific research.

The full MeerKAT array will consist of 64 identical receptors-antennas with receivers, digitisers and other electronics installed. Forty-eight of the antennas will be packed closely together in a 1 km diameter area, with rest located up to 4 km from the core.

Connected by 170 km of underground fibre-optic cable, the 64 receptors will operate as a single, highly sensitive astronomical instrument, controlled and monitored remotely from the MeerKAT control room in Cape Town.

As the government body responsible for the science and technology sector, the Department of Science and Technology (DST) is tasked with developing, coordinating and managing the National System of Innovation (NSI) that will bring about maximum human capital, sustainable economic growth and improved quality of life.

In this context the department is tasked with ensuring greater coordination and integration, as well as better management of all government-funded science and technology institutions, and to provide a holistic overview of public expenditure on science and technology.

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.

## Legislation

The DST is governed by the following legislation:

- Intellectual Property Rights from Publicly Financed Research and Development (IPR) Act, 2008 (Act 51 of 2008): Provides for the more effective use of intellectual property emanating from publicly financed research and development, through the establishment of the National Intellectual Property Management Office (Nipmo), the Intellectual Property Fund, and offices of technology transfer at institutions.
- Technology Innovation Act, 2008 (Act 26 of 2008): Intended to promote the development and exploitation in the public interest of discoveries, inventions, innovations and improvements, and for that purpose establishes the Technology Innovation Agency (TIA).
- South African National Space Agency (Sansa) Act, 2008 (Act 36 of 2008): Establishes the Sansa to promote space science research, cooperation in space-related activities, and the creation of an environment conducive to the development of space technologies by industry.
- Natural Scientific Professions Act, 2003 (Act 27 of 2003): Establishes the South African Council for Natural Scientific Professions, and legislates the registration of professional natural scientists, natural scientists-in-training, natural science technologists and natural science technologists-in-training.
- National Research Foundation (NRF) Act, 1998 (Act 23 of 1998): Establishes the NRF to promote basic and applied research, as well as the extension and transfer of knowledge in the various fields of science and technology.
- National Advisory Council on Innovation (Naci) Act, 1997 (Act 55 of 1997): Establishes the Naci to advise the Minister of Science and Technology on the role and contribution of science, mathematics, innovation and technology in promoting and achieving national objectives.
- Africa Institute of South Africa (Aisa) Act, 2001 (Act 68 of 2001): Establishes the Aisa to promote knowledge and understanding of African affairs by encouraging leading social scientists.
- Human Sciences Research Council (HSRC) Act, 2008 (Act 17 of 2008): Provides for the HSRC, which carries out research that generates critical and independent knowledge relative to all aspects of human and social development.
- The Scientific Research Council Act, 1988 (Act 46 of 1988): Refers to the activities of the Council for Scientific and Industrial Research (CSIR), one of the leading scientific

and technological research, development and implementation organisations in Africa, which undertakes directed research and development for socio-economic growth in areas including the built environment, defence, the environmental sciences, and biological, chemical and laser technologies.

- 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 for intergovernmental cooperation and public consultation on matters concerning nationally significant astronomy advantage areas.
- The Science and Technology Laws, Amendment Act, 2014 (Act 7 of 2014) seeks to, among other things, streamline the process for the nomination and appointment of members of the boards or councils of such entities as well as the filling of vacancies on the boards.
- The Geoscience Amendment Act, 2010 (Act 12 of 2010), amends the Geoscience Act, 1993 (Act 100 of 1993), to mandate the Council for Geoscience (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.
- Sanren, which is responsible for the roll-out of a high-speed broadband network to all academic 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).

## Policy mandate and strategies

The DST's major policy documents are the *White Paper on Science and Technology (1996)*, the 2002 National Development Research Strategy (NRDS), the *New Strategic Management Model for South Africa's Science and Technology System (2004)* – with its Policy on Governance Standards for Science, Engineering and Technology Institutions and Framework for the Development of a National Science and Technology Expenditure Plan – and the 2007 Ten-Year Innovation Plan (TYIP).

The DST is the custodial coordinator for the development of the NSI and influences this system through key strategies such as the NRDS and the TYIP. The latter, particularly, seeks to contribute to the transformation of the South African economy into a knowledge-based economy, in which the production and

dissemination of knowledge will lead to socio-economic benefits and enrich all fields of human endeavour.

### National Research and Development Strategy

The NRDS as the basis for the NSI and requires performance and responses in three key areas, enhanced innovation; providing science, engineering and technology human resources (HR) and transformation; and creating an effective government science and technology system.

A prime objective of the NSI was to enhance the rate and quality of technology transfer from the science, engineering and technology sector by providing quality HR, effective hard technology transfer mechanisms, and creating more effective and efficient users of technology in the business and government sectors.

The White Paper also set out the institutions to be established to promote the development of a well-functioning NSI. These were to be the national Ministry and DST, the National Advisory Council on Innovation, the NRF, the Innovation Fund, and national research facilities managed by government.

The NRDS is aimed at being a key enabler of economic growth alongside other strategies, such as the Human Resource Development Strategy, the Integrated Manufacturing Strategy and the Strategic Plan for South African Agriculture.

### Ten-Year Innovation Plan

The TYIP is aimed at assisting to establish 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.

The missions and platforms under the NRDS were expanded under the TYIP to include grand challenges in space science and technology, energy security, human and social dynamics in development, global change, and the bio-economy.

The responsibility for addressing the grand challenges is spread across many government departments.

The TYIP also set long-term goals based on the grand challenges it identified. They included:

- becoming one of the top three emerging economies in the global pharmaceutical industry, based on innovative use of South Africa's indigenous knowledge and rich biodiversity
- deploying satellites that provide a range of scientific, security and specialised services for all spheres of government, the public and the private sector.
- achieving a 25% share of the global hydrogen and fuel cell market with novel platinum group metal catalysts.
- becoming a world leader in climate science and responding effectively to the multiple challenges associated with global and climate change.
- meeting the 2014 millennium development goal to halve poverty.

The department has set indicators for each of these goals.

### National Nanotechnology Strategy

Nanoscience and nanotechnology are the study and application of extremely small things and can be used across all the other science fields, such as chemistry, biology, physics, materials science, and engineering.

Microscopy – the technical field of using microscopes to view samples and objects that cannot be seen with the unaided eye – was a boon to emerging research areas such as nanotechnology. This was aligned with the objectives of the National Nanotechnology Strategy. The growth of microscopy is essential to help government expand its research capabilities in important health- and economy related fields. The NRF has been supporting the microscopy community.

The department funded the establishment of the state-of-the-art specialised facility, the Centre for High Resolution Transmission Electron Microscopy, based at the Nelson Mandela Metropolitan University in Port Elizabeth.

The department has invested R84 million in support of the centre through which South Africa is firmly positioned as a global player in the high-resolution arena. This investment is expected to translate into cutting-edge research and development capacity, providing young scientists with high-end skills and attracting beneficial collaborative partnerships internationally.

Given the importance and growth of microscopy, the DST regards it as crucial in addressing some of the strategic priorities in the areas of human capital development by training competent technicians to do research into HIV, mining and many other fields, using the high-end microscopes that the department has funded.

In July 2013, the Department of Science and Technology (DST) launched the South African version of the Scientific Electronic Library Online (SciELO-SA). It's a searchable full-text journal database that is completely open-access. The project is funded by the DST, maintained by the Academy of Science of South Africa, and endorsed by the Department of Higher Education and Training. South Africa joined SciELO in 2009.

## Budget and funding

The DST received R6,2 billion in 2013/14. Almost all of this (about 92%) went to science councils and agencies, and to other research institutions, including universities – which the department supports in various ways.

As approved in the Medium Term Expenditure Framework (MTEF), the DST allocated additional funds: R87 million, R310 million and R401 million in the 2012/13, 2013/14 and 2014/15 financial years, respectively, to relevant NRF programmes.

New-generation researchers are set to get R450 million; emerging researchers will get R196 million, and postgraduate bursaries are allocated R340 million.

The NRF's internship programme will receive an increased allocation of R110 million over the next three years.

The department received official development assistance from Australia, Canada, the European Community, Finland, the United States Agency for International Development (USAID) and Japan.

## Role players

### Academy of Science of South Africa (ASSAf)

ASSAf was inaugurated in May 1996 by former President and patron of the Academy, Nelson Mandela. It was formed in response to the need for an academy of science congruent with the dawn of democracy in South Africa – activist in its mission of using science for the benefit of society.

ASSAf is the official national academy of science in the country and represents the country in the international community of science academies.

### Africa Institute of South Africa

Aisa is a statutory body following the Aisa Act of 2001. Aisa's mandate is to produce knowledge aimed at informing sustainable political and socio-economic development in Africa. Its vision is to be an indispensable African voice on African Affairs, and its 2011 to 2015 research agenda is to seek solutions for Africa's developmental challenges.

Through its annual training programme that educates students from universities in research methodologies, Aisa has contributed to fostering a new generation of research specialists.

The institute has also been able to produce some of the finest research into contemporary African Affairs by field research every year throughout Africa. This means that all research output is based on first-hand empirical evidence.

Aisa has also become involved in community outreach programmes by providing maps and other resources to underprivileged schools in rural areas. The institute has undertaken to promote knowledge creation as a fundamental part of development and growth for Africa. As such, it aims to encourage research as a career choice for young people as they leave school.

## Council for Scientific and Industrial Research

The CSIR is one of the leading science and technology research, development and implementation organisations in Africa. The CSIR's main site is in Pretoria, Gauteng, and it is represented in other provinces of South Africa through regional offices.

The generation and application of knowledge reside at the core of the CSIR. This takes place in domains such as biosciences; the built environment; defence, peace, safety and security; materials science and manufacturing; and natural resources and the environment.

Emerging areas of research include 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.

The CSIR houses specialist research facilities of strategic importance for African science. These include information and communications technology (ICTs); laser technology, and space-related technology.

Research and development 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 include forensic fire investigations, food and beverage analysis, environmental testing, engineering forensics, wire rope testing, mechanical testing, fire and explosion tests, sports technology and analysis, and project management.

In September 2013, researchers at the CSIR developed the world's first digital laser.

The innovation, according to CSIR researchers, is regarded as a milestone in laser technology and could spur future laser-related innovations. Researchers say the development of the digital laser could have possible applications predominantly in the health, manufacturing and communications sectors, and other industries.

The team of researchers behind the innovation describe the development of the digital laser as a "disruptive technology," which will help to create

a new market and value network, and eventually disrupt the existing market and value network over time.

### Human Sciences Research Council

The HSRC conducts large-scale, policy-relevant, social-scientific projects for public-sector users, non-governmental organisations and international development agencies. This is done in partnership with researchers globally, but specifically in Africa. The HSRC serves as a knowledge hub to bridge the gap between research, policy and action; thus increasing the impact of research.

The HSRC's six multidisciplinary research programmes are:

- education and skills development
- economic performance and development
- population health
- health systems and innovation
- HIV and AIDS, sexually transmitted infections and tuberculosis (TB)
- democracy, governance and service delivery
- human and social development.

The council's centres are the Centre for Science, Technology and Innovation Indicators; and the Centre for the Study of the Social and Environmental Determinants of Nutrition.

The HSRC Press is South Africa's only open-access publisher and is committed to the dissemination of high-quality, social-science research-based publications, in print and electronic form. HSRC Press publishes the research output of the HSRC as well as externally authored works.

### National Advisory Council on Innovation

Naci advises the Minister of Science and Technology on the role and contribution of innovation in promoting and achieving national objectives, namely to:

- improve and sustain the quality of life of all South Africans
- develop human resources for science and technology
- build the economy

The first ever evidence of a comet entering Earth's atmosphere and exploding was discovered by a team of South African scientists and international collaborators in October 2013. Professor David Block of Wits University, Professor Jan Kramers of the University of Johannesburg, Dr Marco Andreoli of the South African Nuclear Energy Corporation, and Chris Harris of the University of Cape Town, conducted highly sophisticated chemical analyses on black pebble found years earlier by an Egyptian geologist in the area of the impact. They came to the conclusion that it represented the first known hand specimen of a comet nucleus, rather than simply an unusual type of meteorite.

- strengthen the country's competitiveness in the international sphere.

The membership of Naci is broadly representative of all sectors and is constituted in a manner that ensures a spread of expertise and experience regarding:

- national and provincial interests
- scientific and technological innovation
- the needs and opportunities in different socio-economic fields
- research and development in all sectors.

### 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 provides services to the research community, especially at higher education institutions and science councils, with a view to promoting high-level human capital development. The NRF aims to uphold excellence in all its investments in knowledge, people and infrastructure.

The NRF consists of three divisions namely: Research and Innovation Support and Advancement Agency (Risa), which constitutes the research support and promotion agency of the NRF; South African Agency for Science and Technology Advancement (Saasta), which provides and manages cross-cutting activities that advance science and technology in various communities in South Africa; and the national research facilities that undertake research in specific research fields.

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 science and technology information to guide and steer strategic decisions.

Through Saasta, the NRF:

- steers young minds towards careers in science and technology
- interacts with the public on science, engineering and technology issues
- communicates the advances of science and technology 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 NRF aims to contribute to the knowledge economy in South Africa by attaining at least 1% of global research and development output by 2015.

## South African National Space Agency

Sansa was created to promote the use of space and cooperation in space-related activities while fostering research in space science, advancing scientific engineering through the development of South Africa's human capital and providing support to industrial development in space technologies.

The objectives of Sansa are to:

- promote the peaceful use of space
- support the creation of an environment conducive to industrial development in space technology
- foster research in space science, communications, navigation and space physics
- advance scientific, engineering and technological competencies and capabilities through human capital development outreach programmes and infrastructure development
- foster international cooperation in space-related activities.

In March 2013, the Sansa and the Russian Federal Space Agency (Roscosmos) signed the RadioAstron space satellite agreement. The agreement paved the way for the two countries to work together on the development of science and space technologies.

If considered as a single, virtual telescope, RadioAstron would be the world's largest radio telescope, with a dish measuring about 390 000 km (almost 30 times the Earth's diameter or about the same size as the distance between the Earth and the moon).

Telkom has made an 18-m C-Band antenna available for RadioAstron tracking and acquisition in South Africa.

Under the agreement, Roscosmos will provide the hardware for upgrading the tracking station (antenna) for compatibility with RadioAstron, while Sansa will install and maintain the upgraded hardware and operate the tracking station.

## Technology Innovation Agency

The TIA was established with the objective of stimulating and intensifying technological innovation to improve economic growth and the quality of life of all South Africans by developing and exploiting technological innovations.

Its core business objective is to support the development and commercialisation of competitive technology-based services and products. The agency primarily uses South Africa's science and technology base to develop new industries, create sustainable jobs and help diversify the

economy. It invests in the following technology sectors: advanced manufacturing, agriculture, industrial biotechnology, health, mining, energy and ICT.

The agency seeks to achieve its mandate by providing financial and non-financial support to its stakeholders, namely science councils, public entities, higher education Institutions, private research institutions and entrepreneurs.

## National Intellectual Property Management Office

Nipmo aims to ensure that recipients of funding from a government funding agency assess, record and report on the benefit to society of IP emanating from publicly financed research and development. Recipients must protect IP emanating from publicly financed research and development from appropriation and ensure that it is available to the people of South Africa.

A recipient must identify commercialisation opportunities for IP emanating from publicly financed research and development.

## Agricultural Research Council (ARC)

The ARC 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.

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
- 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.

## 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

In November 2013, a group of more than 40 students from the CubeSat Programme at the French South African Institute of Technology at the Cape Peninsula University of Technology participated in building Africa's first cube satellite. The ZACUBE-1 satellite was launched from Yasny in Russia. The Department of Science and Technology funded the project with R22 million.

related areas. Working closely with industry and other research and development 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 Mineral Resources. About 35% of the annual budget is funded by the State Science Vote, with the balance provided by contract research and development, 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 research and development specialists.

### Medical Research Council (MRC)

The MRC is an independent statutory body that coordinates health and medical research activities throughout South Africa. The MRC's objectives are:

- promoting the health and quality of life of the population of South Africa
- performing such functions as may be assigned to the MRC by or under the MRC Act, 1991 (Act 58 of 1991).

The MRC is a science council and therefore also a science, engineering and technology institution.

### Council for Geoscience

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.

In 2013, the Minister of Science and Technology, paid a courtesy visit to the Helmholtz Centre for Geosciences in Berlin. The visit to the centre was also aimed at strengthening existing research relations in the field of geosciences, particularly earth sciences.

South Africa and Germany have been collaborating in Inkaba-ye Africa (IyA) since 2003, in an effort to deal with the pressing challenges of global change.

A joint initiative between the DST and the German Federal Ministry of Education and Research, the Year of Science, celebrated 16 years of successful cooperation on science and technology between the two countries.

The DST committed R4 million towards improving the skills base in South Africa, aimed at understanding the earth system, in a major research programme in partnership with Germany. This commitment will support the

project for a further five years, commencing in 2013/14.

More than 20 German and South African universities and research institutions have participated in IyA, and in as many sub-projects studying complex systems of the solid earth, the biosphere, atmosphere and oceans.

More than 210 postgraduate students from both countries have since completed degrees, which has resulted in a marked rise in graduation rates over the last few years.

The programme has also contributed more than 70 research papers published in leading international journals in the field of earth systems research, with a number of smaller spin-off projects arising from the cooperation.

The Africa Earth Observatory Network is the leading network of the cooperation programme on South Africa's side with Germany led by the German Research Centre for Geosciences.

### South African Bureau of Standards (SABS)

The SABS is a statutory body that operates 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 change 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.

## 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 research and development facilities that form the heart of the Sasol technology research and development group.

Focused FT research and development 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, research and development, and new product formulation and testing.

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.

## ArcelorMittal

ArcelorMittal is a global steel-maker, with an industrial presence in 27 countries. It is the leader in all major global markets, including automotive, construction, household appliances and packaging. The group is a leader in research and development, and technology, holds sizeable captive supplies of raw material, and operates extensive distribution networks.

## National Health Laboratory Service (NHLS)

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 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.

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, in the 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 are 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 analysis 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. Its tasks involve:

- conducting research into 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 at national, regional and international levels.

### **South Africa's National Energy Development Institute (Sanedi)**

The DST and the Department of Energy are joint custodians of Sanedi and assist in providing political and strategic focus for the company.

The institute is entrusted with the coordination and undertaking of public interest energy research, development and demonstration.

As such, it is responsible for enabling and implementing the energy technology roadmaps, which support long-term energy policies developed by the Department of Energy.

### **Safety in Mines Research Advisory Committee**

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.

### **National Agricultural Research Forum (NARF)**

The NARF coordinates agricultural research and development in the national agricultural research system.

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 Commission (WRC)**

The WRC was established in 1971 following a period of water shortages. The WRC is responsible for:

- promoting coordination, cooperation and communication in the area of water research and development
- 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 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 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.

### **Institute for Water Research**

The Institute for Water Research is a multidisciplinary research department of Rhodes University in the Eastern Cape. 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.

### **South African National Biodiversity Institute (Sanbi)**

The 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.

## 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.

## 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)

SAAO is the national centre for optical and infrared astronomy in South Africa. 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 contributes to South Africa's future development by creating and disseminating scientific knowledge; providing research infrastructure; and providing an interface between science and society. It is also responsible for managing the operations of the South African Large Telescope (Salt).

### Hartebeesthoek Radio Astronomy Observatory (HartRAO)

The HartRAO is a radio astronomy observatory located in a natural bowl of hills at Hartebeesthoek just south of the Magaliesberg mountain range, Gauteng. It is the only major radio astronomy observatory in Africa.

HartRAO is mainly used for continuum radiometry, spectroscopy, pulsar timing and interferometry but also works together with radio telescopes on other continents as well as the orbiting Highly Advanced Laboratory for Communications and Astronomy radio telescope to perform very long baseline interferometry.

### South African Institute for Aquatic Biodiversity (Saiab)

Situated in Grahamstown in the Eastern Cape, Saiab is an internationally recognised centre for the study of aquatic biodiversity.

Saiab runs a number of large, interdisciplinary and multi-institutional programmes.

The research facility is directed at fish taxonomy, systematics, genetics, phylogeography, biology, ecology, ethology, conservation, and fisheries management.

### South African Environmental Observation Network (Saeon)

Saeon maintains environmental observatories, field stations or sites linked by an information management network to serve as research and education platforms for long-term studies of ecosystems that will provide for incremental advances in our understanding of ecosystems and our ability to detect, predict and react to environmental change.

The core research programme distinguishes between anthropogenic and natural change as well as unravels the relations between social and ecosystem change.

### National Zoological Gardens (NZG)

Inspired conservation of wildlife through understanding, knowledge and connection, as the vision and mission statements, reflect a commitment by the NZG to bridge the gap between nature and humanity.

This is done by providing a platform on which humanity can gain knowledge about, cultivate a better understanding of and connect with nature in general, but wildlife in particular.

### iThemba Laboratory for Accelerator-Based Sciences

iThemba LABS is a multidisciplinary facility aiming to become the leading African organisation for research, training and expertise in accelerator-based science and technologies.

The infrastructure is based at two sites, namely in the Western Cape, on Old Faure Road, and in Gauteng, on the campus of the University of the Witwatersrand.

## Programmes and projects

The DST has four main programmes, which represent distinct but complementary ways of promoting the NSI, and harnessing science and technology to benefit all South Africans.

### Research, Development and Innovation (RDI)

This is at the heart of the department's efforts to drive innovation in scientifically strategic areas.

The programme has five subprogrammes:

- space science and technology
- hydrogen and energy
- biotechnology and health innovation

- innovation planning and instruments
- radio astronomy advances.

## Space science and technology

### Square Kilometre Array

The SKA Project could act as a catalyst for science, technology and engineering business opportunities, jobs and innovation, and has the potential to put Africa on the map as a world Big data and analytics hub.

The multi billion rand SKA, to be hosted in South Africa and Australia, will extend into eight African countries and will be the world's biggest telescope. It is also one of the biggest-ever scientific projects and multinational collaborations in the name of science.

The radio telescope should be operationally mature by 2020.

With thousands of linked radio wave receptors in Australia and in southern Africa, the SKA radio telescope will constantly scan space and feed the data to astronomers around the world.

The amounts of data being collected and transmitted by the SKA in a single day would take nearly two million years to play back on an iPod. This means the project requires supercomputing power and Big Data management and analytics capabilities on an unprecedented scale. The SKA is working with the world's most significant ICT powerhouses on the project.

One aspect of the project will see the Netherlands Institute for Radio Astronomy and IBM collaborating to research extremely fast, but low-power exascale computer systems, data transport and storage processes, and streaming analytics that will be required to read, store and analyse all the raw data that will be collected daily.

The SKA project will also have unprecedented data connectivity needs. Meeting the advanced technological and engineering needs of this project will result in significant local skills development, revolutionise science and technology research and enable innovative new businesses and employment in the science, technology and engineering fields.

Aside from the benefits to African science, Big Data capabilities could be the biggest spin-off from the SKA project.

The innovations, skills development and commercial potential emerging as a result of the project are huge. The potential is not just academic – the taxpayer-funded IP is developed to a point where it is ready to become commercialised and benefit the economy.

Human capital development is already taking place as a result of the SKA project, with bursaries and scholarships being granted to allow students to learn the necessary cutting-edge science, technology, maths and engineering

skills to support the project. Because the SKA is a long-term project over decades, its effect will increase.

Going forward, there will be a strong drive to leverage the SKA as a spearhead for other programmes – including next generation high performance computing challenges and Big Data challenges.

Since 2005, the African SKA Human Capital Development Programme has awarded close to 400 grants for studies in astronomy and engineering from undergraduate to post-doctoral level, while also investing in training programmes for technicians.

Astronomy courses are also being implemented in other African countries, including Kenya, Mozambique, Madagascar and Mauritius. Career opportunities will increase substantially and new business opportunities will emerge.

The project has already changed the world's view of South Africa's scientific capability.

This project is a once-in-a-lifetime combination of science and engineering in South Africa.

## Space science

Through Sansa, the country's capacity to design, build, maintain and possibly even launch satellites is being developed. As part of the four-country African Resource Management Constellation, South Africa has begun work on the ZA-ARMC1 satellite; R232 million has been budgeted over the next three years for this project. This satellite will enhance Africa's ability to monitor and manage its precious natural resources.

A business rescue plan for Sunspace was put in place, and the process of transferring its capabilities and IP into the Sansa satellite programme is continuing.

## Information and communications technology

The DST 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.

South Africa's research capacity in the ICT field has become a strong competitive advantage.

The ICT RDI Strategy aims to achieve a marked increase in advanced human resource capacity, promote world-class research and build robust innovation chains for the creation of new high-tech ICT small enterprises. Implementing the strategy demands partnership involving government, the private sector, higher education 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), Sanren and the Very Large Databases are the three pillars of cyber-infrastructure that the DST supports. Hosted by the University of Cape Town and managed by the CSIR's Meraka Institute, the CHPC was the first of its kind in South Africa and is making scientific supercomputing a reality for South Africa.

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. On completion, the network will reach about 200 sites. 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.

## Indigenous knowledge systems (IKS)

The Indigenous Knowledge System Policy serves as a guide for the recognition, understanding, integration and promotion of South Africa's wealth of indigenous knowledge resources.

One of the areas of action identified by the policy is the protection of indigenous knowledge and the holders of such knowledge against exploitation.

This includes ensuring that communities receive fair and sustained recognition and, where appropriate, financial remuneration for the use of this knowledge.

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

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 DST has three IKS priorities:

- The development of a regulatory environment for the protection of IKS.

- The development of the National Recordal System for the collection, recording, documenting, storage and management and dissemination of IKS in communities in the nine provinces of the country. Until orally 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. The department established IKS documentation centres in all the provinces by 2013.
- Applied research, specifically bio-prospecting activities. An example would be how, with funding from the NRF, the MRC is developing the Moritela Tshwene Tea Project near Zeerust in North West, with the aim of producing a nutritional herbal tea for the commercial market.

The DST 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.

Two indigenous knowledge research chairs have been awarded as part of the country's Research Chairs Initiative (SARChI).

The first was awarded to the University of KwaZulu-Natal for work in the field of traditional medicines. The second was awarded to Walter Sisulu University.

These two chairs represent significant injections into the development of national research capacity in IKS.

The DST also established indigenous knowledge studies CoEs at the universities. The CoEs will play a defining role in generating highly qualified HR capacity in IKS.

## 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)
- Metal Box Company of South Africa (corrosion mechanisms and microbiology)
- Tellumat (develops electronic instruments)
- Rembrandt Group (develops and improves 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).

### Natural-resource development

South Africa's fluorspar chemicals sector has enormous economic potential. The DST has implemented a fluoro-chemicals development programme targeting human-capital development, new business formation and novel processes and products. A multipurpose fluorination pilot plant was completed and launched in 2012.

The department secured a commitment of R60 million for the period 2013 to 2015 from the competitiveness fund announced by the Minister of Finance in 2012.

This enabled it to increase the companies on its register by a further 50 by the end of 2012/13, with an additional 100 planned by the end of 2014/15.

Over the next three years, the department will allocate more than R100 million to the titanium initiative, R50 million of which will come from the economic competitiveness fund.

### Human-capital development

The DST's Human-Capital and Science Platforms Subprogramme conceptualises, formulates and implements programmes

aimed at developing and renewing science, engineering and technology human capital to promote knowledge generation, protection and exploitation.

South African universities train more and more scientists each year, with whose help the country will be able to spend R45 billion on research and development by 2014, thus reaching its target for gross expenditure on research and development of 1,5% of gross domestic product.

Sixty new research chairs were awarded to various institutions of higher learning throughout South Africa during the 2011/12 and 2013/14 MTEF. This increased the number of research chairs in South Africa to 154.

Food security and access to clean water remain among government's top priorities – the department is therefore also focusing on using science and technology to ensure that existing water supplies are clean and is playing an active role in ensuring food security into the future.

To this end, seven of the 60 new research chairs initiated by the department will serve the areas of rural development, food security and land reform, bringing the total of such chairs to 10.

### International cooperation

The DST is not only entrusted with the overall coordination of national research and innovation initiatives in South Africa, but is also responsible for overseeing and facilitating South Africa's international scientific and technological cooperation.

The International Cooperation and Resources Programme of the department is tasked with facilitating and nurturing bilateral scientific cooperation with countries in Africa, Europe, the Americas and Asia.

The same programme nurtures multilateral scientific cooperation with the African Union, the UN system, donor agencies and foundations, global research infra-structure projects, and multinational companies, as well as focused strategic partnerships, such as with the European Union (EU).

The department has three international offices, located at South Africa's diplomatic missions in Tokyo, Moscow and Brussels, dedicated to promoting cooperation with Japan, the Russian Federation and the EU.

The DST has also seconded an official to the secretariat of the SADC in Gaborone, Botswana.

Many of South Africa's national science councils or other public-funded research and technology organisations also have dedicated teams working on international cooperation. These include the NRF, which is responsible for

the implementation of international science and technology cooperation agreements.

### **African Network on Drugs and Diagnostics Innovation (Andi)**

Andi is based in Addis Ababa, Ethiopia, at the UN offices of the Economic Commission for Africa. Its board agreed that five regional hubs were to be created to support regional research initiatives, with South Africa offering to host the southern hub.

Andi evaluated African research initiatives on drugs and diagnostics, and identified 35 CoEs throughout Africa that were to receive priority attention. Fifteen of these are in South Africa.

All the centres are tasked with researching responses to the most intractable health burdens of the continent, from malaria and tuberculosis to river blindness. Many of these are diseases of the poor and invisible. Their researchers do not receive funding or intellectual support from established agencies – Andi's aim is to reverse this.

It provides support to innovation in quality water provision that is community-led and -based through various agencies. It supported the development and use of new energy-efficient and attractive construction materials through the CSIR-led infrastructure innovation programme – 410 houses were built in Kleinmond, creating an integrated suburb.

It supports rural-based poverty alleviation initiatives in Limpopo, the Eastern Cape and

KwaZulu-Natal. Another facet of Andi is the Ketlaphela/Lonza initiative that built a plant to manufacture active pharmaceutical ingredients for antiretroviral (ARV) production.

The departments of science and technology, trade and industry, economic development and health collaborated on this initiative to secure a significant proportion of the ARV market for local producers.

### **Women in Science Awards**

The South African Women in Science Awards, which is part of government's efforts to recognise and create incentives for women scientists and researchers in the country and to profile successful women scientists, is an annual event, that took place in August 2013.

The objective is to create enough role models for young women and girls.

The theme of the 2013 awards was: "The Role of Science and Research against Violence towards Women."

This is rooted in the UN Commission on the Status of Women's 2013 theme: "Elimination and prevention of all forms of violence against women and girls."

The awards were made in the life sciences and humanities categories and include distinguished women scientists and distinguished young women in science.