

National Research Foundation
ANNUAL PERFORMANCE PLAN
2018/19–2020/21



Advancing knowledge. Transforming lives. Inspiring a nation.



science
& technology

Department:
Science and Technology
REPUBLIC OF SOUTH AFRICA



National
Research
Foundation



“The NRF is
securing a brighter future
for South Africa and its citizens
by promoting and supporting
research excellence, human
capacity development and
creation of a knowledge
society.”

It is hereby certified that this Annual Performance Plan:

- Was developed by the management of the National Research Foundation (NRF) under the guidance of the NRF Board;
- Takes into account all the relevant policies, legislation, plans and mandates applicable to the NRF; and
- Accurately reflects the strategic outcome-orientated goals and objectives which the NRF will endeavour to achieve over the period 2018–2021 (with a particular focus on 2018/19) covered by the plan.



Mr Bishen Singh
Chief Financial Officer



Dr Molapo Qhobela
Chief Executive Officer

The Board of the NRF hereby tables the Annual Performance Plan of the NRF for the period 2018/19 – 2020/21 for approval:



Prof. Loyiso Nongxa
NRF Board Chairman
(Accounting Authority of the NRF)



The Honourable Mrs Naledi Pandor
Minister of Science and Technology
(Executive Authority of the NRF)



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Science and Technology
REPUBLIC OF SOUTH AFRICA



**National
Research
Foundation**



CEO OVERVIEW

1

Dr Molapo Qhobela Chief Executive Officer

It is my pleasure to present the Annual Performance Plan (APP) of the National Research Foundation (NRF) for the period 2018/19 to 2020/21. The APP was developed by the management, under the leadership of the NRF Board. It reflects the implementation plan, inclusive of key performance indicators and targets of *NRF Strategy 2020*. The latter is derived from the organisation's legislative mandate and informed by government's priorities and policies, in particular the National Development Plan (NDP) "Vision 2030".

A continued priority of government is transformation of our society and economy, including the research and innovation system. The latter is acknowledged as key enablers by the NDP. The NRF will continue to contribute through its transformation framework, which focuses on four main areas, being the equity profile of postgraduate students and researchers; the knowledge enterprise; the relationship between science and society; and transformation of the NRF itself.

As the principal funding agency of government providing postgraduate student bursaries, research and equipment grants to researchers, the organisation will fund 3 279 researchers and 12 373 postgraduate students in the 2018/19 financial year. These initiatives will be guided by the goal of realising a fully representative science and technology workforce whose research, teaching and engagement efforts impact positively on society. An ongoing challenge for the organisation is the need to significantly increase investments to improve the adequacy and reach to diverse postgraduate students; renewal and acquisition of essential research infrastructure which is relevant and performing at an appropriately high level to support researchers and students; and an enhanced relationship between science and society.

During the 2018/19 to 2020/21 MTEF, the NRF will also intensify the promotion, support and advancement of research excellence through various interventions, including programmes to develop and

“The position of the NRF as a high performing and respected science granting agency will be enhanced during the forthcoming period. This will be achieved through continued efforts to forge networks and partnerships with the government, private sector, local and international research performing agencies, including other stakeholders.”

support early career researchers to become internationally acclaimed researchers and scholars over time.

Even under very challenging financial conditions, wherein the parliamentary grant again decreased by 1% in real terms, the NRF will continue to invest in necessary and critical national research infrastructure. In the 2018/19 financial year, R401m will be invested to support research infrastructure for astronomy, biodiversity, environmental sciences and nuclear science research.

The position of the NRF as a high performing and respected science granting agency will be enhanced during the forthcoming period. This will be achieved through continued efforts to forge networks and partnerships with the government, private sector, local and international research performing agencies, including other stakeholders. Those networks and partnerships will be grounded on the principle of

strategic partnership as an essential element of delivery on the mandate of the NRF.

On behalf of the executive management team of the NRF, I wish to thank the NRF Board under the guidance of its Chairman, Prof. Loyiso Nongxa. I also wish to thank the Honourable Minister of Science and Technology, Mrs Naledi Pandor, MP, and the entire leadership of her Department for their constructive engagements with the Board and the executive management of the NRF. I similarly wish to acknowledge and appreciate the rigorous engagements with the Parliamentary Portfolio Committee for Science and Technology in exercise of their oversight role. Lastly, I wish to thank the entire management and staff of the NRF for their contribution towards the success of the organisation in contributing to national development.



UMBIKO KA-CEO

1

UDkt. Molapo Qhobela
Isikhulu Esiyinhloko Sabaphathi

Kuyinjabulo ngami ukwethula uHlelo loMsebenzi lwaMinyaka Yonke (APP) lwe-National Research Foundation (NRF) lonyaka ka-2018/19 ukuya ku-2020/21. I-APP imiswe abaphathi ngokwabo, iqondiswa yiBhodi le-NRF. Loluhlelo luveza isimiso somsebenzi, oluhlela izinkomba eziyinhloko zendlela esiwufeza ngayo umsebenzi wethu nemigomo ye-NRF Strategy 2020. Loluhlelo luthathelwa emsebenzini wenkampani ngokwesishayamthetho futhi luqondiswa izinto ezibalulekile nemigomo kahulumeni, ikakhulukazi i-National Development Plan (NDP) “Umgomo ka-2030”.

Uhulumeni uqhubekela phambili nokubeka kuqala ukuletha ushintsho emphakathini wethu nasesimweni somnotho, kanye nenqubo yocwaningo nokuvula amathuba amasha lapho lezizinto ziqashelwa khona njengezisekelo ezibalulekile ze-NDP. I-NRF izoqhubeka ibamba iqhaza ngohlelo lwayo lokuletha ushintsho, olugxile kakhulu ezingxenyeni ezine eziyinhloko, okuwukuthi; isizinda sabafundi bezimfundo eziphakeme kakhulu nabacwaningi; inqubo yomthombo

wokuthola ulwazi; ubudlelwane phakathi kwezesayensi nomphakathi kanye noshintsho lwe-NRF ngokwayo.

Njengoba kuyiyona ngokuyinhloko exhasa abafundi bezimfundo eziphakeme kakhulu kuhulumeni ngomfundaze, ukucwaninga namathuluzi ahlinzekwa abacwaningi, lenhlangano izoxhasa abacwaningi abangu-3 279 abafundi bezimfundzo eziphakeme kakhulu abangu-12 373 onyakeni wezimfundo ka-2018/19. Lezinyathelo zizoqondiswa umgomo wokumisa iqembu labasebenzi abahlukahlukene bezesayensi nezobuciko abazoletsa inthuthuko ngokucwaninga, nokufundisa umphakathi. Inselele eqhubekayo ebhekene nenkampani ukwandisa ukutshalwa kwezimali zokuthuthukisa ikhono lokufeza umsebenzi nokufinyelela abafundi abahlukahlukene bemfundo ephakeme kakhulu; ukuvuselelwa nokumiswa kwengqalazinda yokucwaninga esebenzisekayo futhi ekwaziyo ukweseka ngokwengeziwe abacwaningi nabafundi; kanye nobudlelwane obungcono phakathi kwezesayensi nomphakathi.

“Enkathini elandelayo kuzothuthukiswa isimo se-NRF njengommeli okhizayo kwezesayensi futhi ohlinishwayo. Lokhu kuzofinyelelwa ngokuqhubeka sizikhandla ngokusebenzisana nokubambisana noHulumenni, amabhizinisi azimele, iminyango yasekhaya neyamazwe angaphandle kwezokucwaninga, kanye nabanye abahilelekile.”

Phakathi kuka-2018/19 no-2020/21 MTEF, i-NRF izosebenza kanzima ukuze ihlongoze, isekele futhi ithuthukise ubuhlakani kwezesayensi ngezinqubo ezihlukahlukene, kanye nokumisa izinhlelo zokuthuthukisa nokusekela abacwaningi abasha emisebenzini yabo ukuze bafinyelele ukuba abacwaningi nabafundi abaqashelwayo emhlabeni kabanzi.

Ngisho nangaphansi kwezimo ezinzima ngokwezimali, lapho uxhaso lwephalamende luphinde lwehliswa ngo-0.8% ngokuqondile, i-NRF izoqhubeka ixhasa inqalasisinda edingekayo nebalulekile ocwaningweni lukazwelonke. Onyakeni wezimali ka-2018/19, kuzosetshenziswa u-R383m ukweseka inqalasisinda yocwanningo kulwazi lwezinkanyezi, ezezitshalo, isayensi, isayensi yendalo nocwanningo lwesayensi yenyukliya.

Enkathini elandelayo kuzothuthukiswa isimo se-NRF njengommeli okhizayo kwezesayensi futhi ohlinishwayo. Lokhu kuzofinyelelwa ngokuqhubeka sizikhandla ngokusebenzisana nokubambisana

noHulumenni, amabhizinisi azimele, iminyango yasekhaya neyamazwe angaphandle kwezokucwaninga, kanye nabanye abahilelekile. Lobudlelwane nokusebenzisana kuzoqondiswa ukuhlelwa kwezinto ngobuhlakani ukuze i-NRF ikwazi ukuwufeza ngokugcwele umsebenzi owabelwe.

Egameni leqembu labaphathi abakhulu be-NRF, ngithanda ukubonga iBhodi le-NRF ngaphansi kukaSihlalo uProfesa Loyiso Nongxa. Futhi ngithanda ukubonga uNgqongqoshe wezeSayensi nezobuchwepheshe, uMhlonishwa, uNkosikazi GNM Pandor, MP, nabaholi bonke boMnyango ngemibono yabo eyakhayo kanye neBhodi nabaphathi abaphakeme be-NRF. Futhi ngithanda ukubonga nokuveza ukwazisa kwiKomiti yoMnyango weSayensi Nobuciko yePhalamende ngokuqondisa kwayo. Ekuphetheni, ngithanda ukubonga bonke abaphathi nabasebenzi be-NRF ngokubamba eqhaza ekuphumeleleni kwenkampani ukuze kuthuthukiswe isizwe.



KAKARETŠO YA MOHLANKEDI-MOGOLOPHETHIŠII

1

Ngaka Molapo Qhobela
Mohlankedimogophethisi

Ke thabile go aba Thulaganyo ya Phethagatšo ya Ngwaga le Ngwaga (APP) ya Motheo wa Dinyakišišo wa Setšhaba (NRF) ya paka ya 2018/19 – 2020/21. APP e hlomilwe ke bolaodi, ka fase ga boetapele bja Boto ya NRF. E tšweletša phethagatšo ya thulaganyo, go akaretšwa ditlahlhi tša phethagatšo tša motheo le maikemišetšo a *NRF Strategy 2020*. Sephetho se tšwa go taolelo ya theramelao ya mokgatlo gomme se tsebišwa ke dilo tše bohlokwa tša mmušo le dipholisi, kudu Thulaganyo ya Tlhabollo ya Setšhaba (NDP) “*Vision 2030*”.

Dilo tše bohlokwa tša mmušo tše di tšwelago pele ke phetošo ya setšhaba sa rena le ekonomi, go akaretša dinyakišišo le mokgwa wa tšweletšopele mola sephetho se amogelwago bjalo ka dikgontšhi tša motheo ke NDP. NRF e tla tšwela pele go kgatha tema ka tlhako ya yona ya phethošo, yeo e nepišago dikarolo tše dikgolo tše nne, e lego; profaele ya tekatekano ya baithuti ba dialogadigolwane le banyakišiši; kgwebo ya tsebo; kamano gare ga saense le setšhaba go akaretšwa phetošo ya NRF ka boyona.

Bjalo ka mmaditselamogolo wa thekgo ya ditšhelete wa mmušo yo a abago dipasari tša dialogadigolwane, dithušo tša dinyakišišo le didirišwa tša dinyakišišo, mokgatlo o tla thekga ka ditšhelete banyakišiši ba 3 279 le baithuti ba dialogadigolwane ba 12 373 mo ngwageng wa ditšhelete wa 2018/19. Mananeo a tla hlhlwa ke tebanyo ya go lemoga kemedi ya go felelela ya badirišani ba saense le theknolotši bao maitapišo a bona a dinyakišišo, go ruta le go kgatha tema go dirago phapano setšhabeng. Tlhohlo yeo e tšwelago pele ya mokgatlo ke tlhokego ya go oketša kudu dipeeletšo go kaonafatša bokgoni le go fihlelela baithuti ba dialogadigolwane ba go fapana; go mpshafatša le go fihlelela infrastraktšha ya dinyakišišo ye bohlokwa ye e lego maleba gomme e šoma ka legato la godimo la maleba go thekga banyakišiši le baithuti; le kamano ye e kaonafaditšwego gare ga saense le theknolotši.

Nakong ya MTEF ya 2018/19 go ya go 2020/21, NRF e tla matlafatša gape tlhahlošo, thekgo le kaonafatšo ya bokgoni bja dinyakišišo ka

“Maemo a NRF bjalo ka mmaditsela wa go aba thušo ya saense yo a hlomphegago wa maemo a godimo a phethagatšo a tla kaonafala nakong ye e tlogo. Se se tla fihlelelwa ka maitapišo a go tšwela pele go aga dinetweke le ditirišano le Mmušo, lekala la praebete, baemedi ba phethagatšo ya dinyakišišo ba gae le ba ditšhabatšhaba, go akaretša bakgathatema.”

ditsenogare tša go fapana, go akaretša go godiša mananeo a go godiša le go thekga dinyakišišo bao ba sa thomago mošomo gore e be dinyakišišo le baithuti bao ba retwago ditšhabatšhabeng mo nakong ye e tlogo.

Le ka fase ga maemo a ditšhelete ao a nago le ditlhohlo, moo thušo ya palamente e fokotšegilego gape ka 0.8% go lebeletšwe infleišene, NRF e tla tšwela pele go beeletša go infrastraktšha ya dinyakišišo ya setšhaba ye bohlokwa gape ye e hlokegago. Mo ngwageng wa ditšhelete wa 2018/19, R383m e tla beeletšwa go thekga infrastraktšha ya dinyakišišo tša astronomi, phapano ya thutaphedi, disaense tša tikologo le dinyakišišo tša saense ya nyuklea.

Maemo a NRF bjalo ka mmaditsela wa go aba thušo ya saense yo a hlomphegago wa maemo a godimo a phethagatšo a tla kaonafala nakong ye e tlogo. Se se tla fihlelelwa ka maitapišo a go tšwela pele go aga dinetweke le ditirišano le Mmušo, lekala la praebete, baemedi ba

phethagatšo ya dinyakišišo ba gae le ba ditšhabatšhaba, go akaretša bakgathatema. Dinetweke tšeo le ditirišano di tla thekgwa ka molao wa tirišano ye e rulagantšwego bjalo ka elemente ye bohlokwa ya go dira ka taolelo ya NRF.

Legatong la sehlopha sa bolaodiphethišo sa NRF, ke rata go leboga kudu Boto ka fase ga tlhahlo ya Modulasetulo wa yona, Profesa Loyiso Nongxa. Ke rata gape go leboga Mohlomphegi Tona ya Saense le Theknolotši, Mdi Naledi Pandor, MP le boetapele ka moka bja Kgoro ya gagwe ka dikgokagano tše bohlokwa le Boto le balaodiphethišo ya NRF. Ke rata gape go amogela le go leboga dikgokagano le Komiti ya Potfolio ya Palamente ya Saense le Theknolotši ka mošomo wa bona wa taolo. Sa mafelelo, ke rata go leboga bolaodi ka moka le badirišani ba NRF ka tema ye ba e kgathilego mo katlegong ya mokgatlo ya go kgatha tema mo tšweletšopeleng ya setšhaba.



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PART A:
STRATEGIC
OVERVIEW



3 INTRODUCTION

The National System of Innovation (NSI) is taken as a set of functioning institutions, organisations and policies which interact constructively in pursuit of a common set of goals and objectives. These goals and objectives are articulated in a range of government policies and strategies, in particular the National Development Plan Vision 2030 (NDP). These include an improved quality of life for all South Africans, underpinned by a robust democracy and just society. In this context, research and innovation are key enablers in achieving these goals. It is further expected that increased public and private sector investment in research and innovation should contribute to improved social and economic development of the country.

As a principal research funding agency of the ministry of Science and Technology and government more generally, the National Research Foundation (NRF) is established as a schedule 3A public entity through the National Research Foundation Act (Act 23 of 1998 as amended). The object of the Foundation, which is currently under review in terms of the NRF Amendment Bill 2016, is to “support and promote research through funding, human resource development and the provision of the necessary research facilities in order to facilitate the creation of knowledge, innovation and development in all fields of science and technology, including indigenous knowledge and thereby to contribute to the improvement of the quality of life of all the people of the Republic.”

The NRF fulfils this mandate by supporting and advancing research excellence through the provision of research and equipment grants; bursaries and fellowships to postgraduate students; and the provision of critical and necessary research infrastructure platforms in astronomy, nuclear sciences, and biodiversity and environmental sciences. The organisation also supports the enhanced engagement between science and society.

The major challenge currently facing the organisation and the country is the ongoing need to accelerate the rate of transformation of the research and innovation system. In this regard the NRF has identified the need to transform the system in all aspects, including representivity. To this end the organisation has prioritised its transformation agenda to focus on four main areas, namely transformation of: the equity profile of postgraduate students and researchers; the knowledge enterprise; the relationship between science and society; and the organisation itself. The success of this endeavour will require, among other things, significant investment and adequate support to enable an increased reach of the number and diversity of postgraduate students; renewal and acquisition of essential research infrastructure to support researchers, students, a responsive and visionary national research agenda; and the enhanced relationship between science and society.

During the 2018/19 financial year, the NRF will receive a parliamentary grant appropriation of R905 m. This will be augmented by R3,418 bn of contracts making an annual income of R4,323 bn. This is a reduction of R823m in nominal terms. While this translates to a decrease of 20% in real terms, the NRF will continue to, effectively and efficiently, within these parameters, support the research community in terms of its mandate. The organisation will also continue to uphold its unwavering commitment to transformation, a strong service culture, good governance, sustainability, and research excellence.



SITUATIONAL ANALYSIS

In support of a knowledge economy, the South African government has targeted a gross expenditure in research and development (GERD) of 1,5% of gross domestic product (GDP) by 2019. GERD is currently at 0.8% of GDP. Currently 43% of the Department of Science and Technology budget is earmarked to deliver on the NRF mandate. This mandate is executed with due regard to the goals of the National Development Plan (NDP) 2030, the Medium Term Strategic Framework (MTSF) priorities and the ever-present commitment to contribute to addressing the triple challenges of unemployment, poverty, and inequality.

The environment in which the NRF is to deliver on its mandate is influenced by multiple factors. In this third year of implementing the NRF strategy, *Strategy 2020*, the organisation is faced with a number of challenges which include a dynamic higher education environment; the ever-evolving local and international science and research environment; and the fiscal challenges of government. In this context, the NRF Board and management have diligently and proactively initiated interventions to ensure its ability to deliver on its mandate within an operational and financial sustainability framework. These include significant cost-containment and austerity measures.

Currently, the role and function of the NRF is being redefined through the National Research Foundation Amendment Bill, 2016. The Bill defines the object of the NRF as contributing to national development by:

- a) Supporting and promoting research through funding, representative human capital development and the provision of the necessary research infrastructure in order to facilitate the creation of knowledge, innovation and development in all fields of science and technology, including humanities, social sciences and indigenous knowledge;
- b) Supporting and maintaining national facilities;
- c) Supporting and promoting public awareness of and engagement with science; and
- d) Promoting the development and maintenance of the National Science System and support of government priorities.

The NRF also welcomes the development of a new White Paper on Science and Technology. This process provides an opportunity to reflect on the numerous successes, as well as the lessons learned over the past 22 years of the 1996 White Paper on Science and Technology.

4.1 MANDATE OF THE NRF

The NRF Act (Act 23 of 1998) sets out the mandate of the organisation as follows:

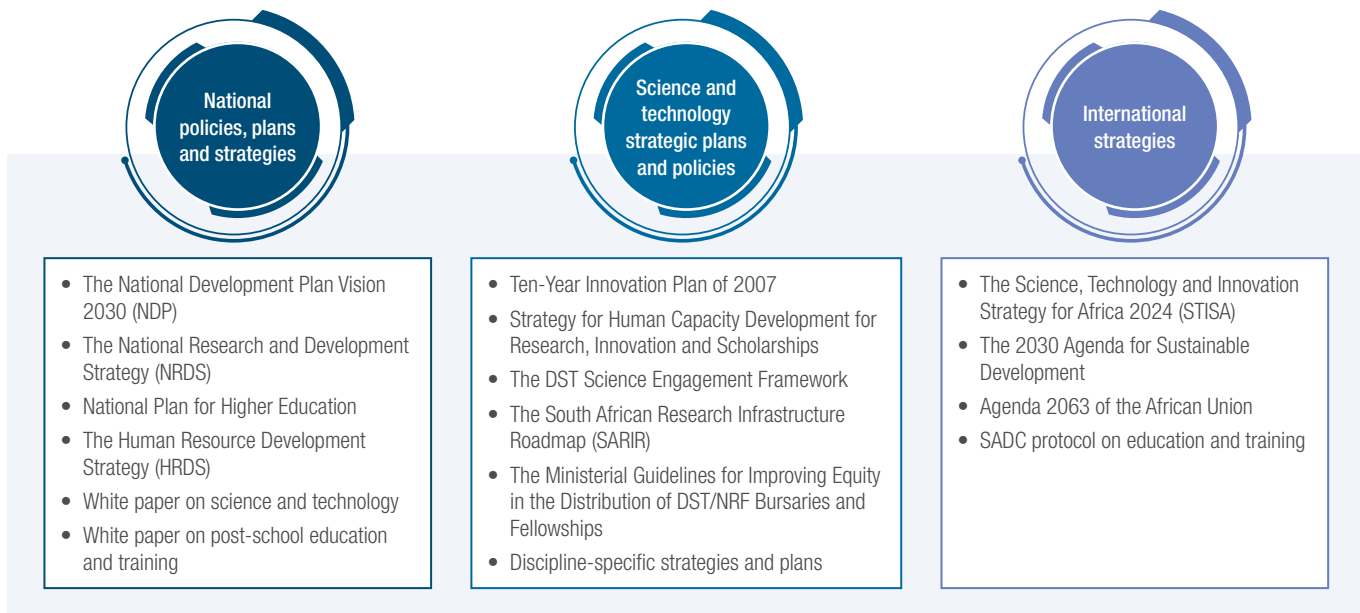
“...to support and promote research through funding, human resource development and the provision of the necessary research facilities in order to facilitate the creation of knowledge, innovation and development in all fields of science and technology, including indigenous knowledge and thereby to contribute to the improvement of the quality of life of all the people of the Republic”. The NRF also supports and promotes awareness of, and engagement with, science in order to improve science literacy and public participation in science, technology, engineering, mathematics, and innovation (STEMI). The organisation supports the Constitutional commitment to “improve the quality of life of all citizens and free the potential of each person”.

4.2 EXECUTION OF THE MANDATE

The NRF executes its mandate through a five-year strategy, *NRF Strategy 2020*. The NRF plays a critical integration role across the public entities in line with government priorities. This allows the organisation to catalyse focused, societally beneficial research and development in support of knowledge generation, human capacity development and innovation.

The strategy takes cognisance of national challenges such as unemployment, poverty and inequality, as well as the national and relevant international policies and strategies as exemplified in Figure 1:

Figure 1: NRF policy environment



4.2.1 NRF STRATEGY 2020 – VISION AND MISSION

The vision and mission of the *NRF Strategy 2020* are supported by four core tenets of transformation, sustainability, excellence and a strong service culture. These are informed by a set of organisational values which, in turn, shape the delivery of the strategic outcomes and objectives.

The NRF vision statement is:

...Catalysing knowledge production for societal benefit.

The organisational mission is:

...To contribute to the knowledge economy in South Africa by attaining at least 1% of the global research and development (R&D) output by 2020.

4.2.2 NRF STRATEGY 2020 – NRF ORGANISATIONAL VALUES

The NRF values are grounded on inclusivity and a tapestry of individual, cultural, and societal values and ethics, and promote strength in diversity, equality, equity, community, and sustainability. These values are cited below in Figure 2.

4.2.3 NRF STRATEGY 2020 – STRATEGIC OUTCOMES AND OBJECTIVES

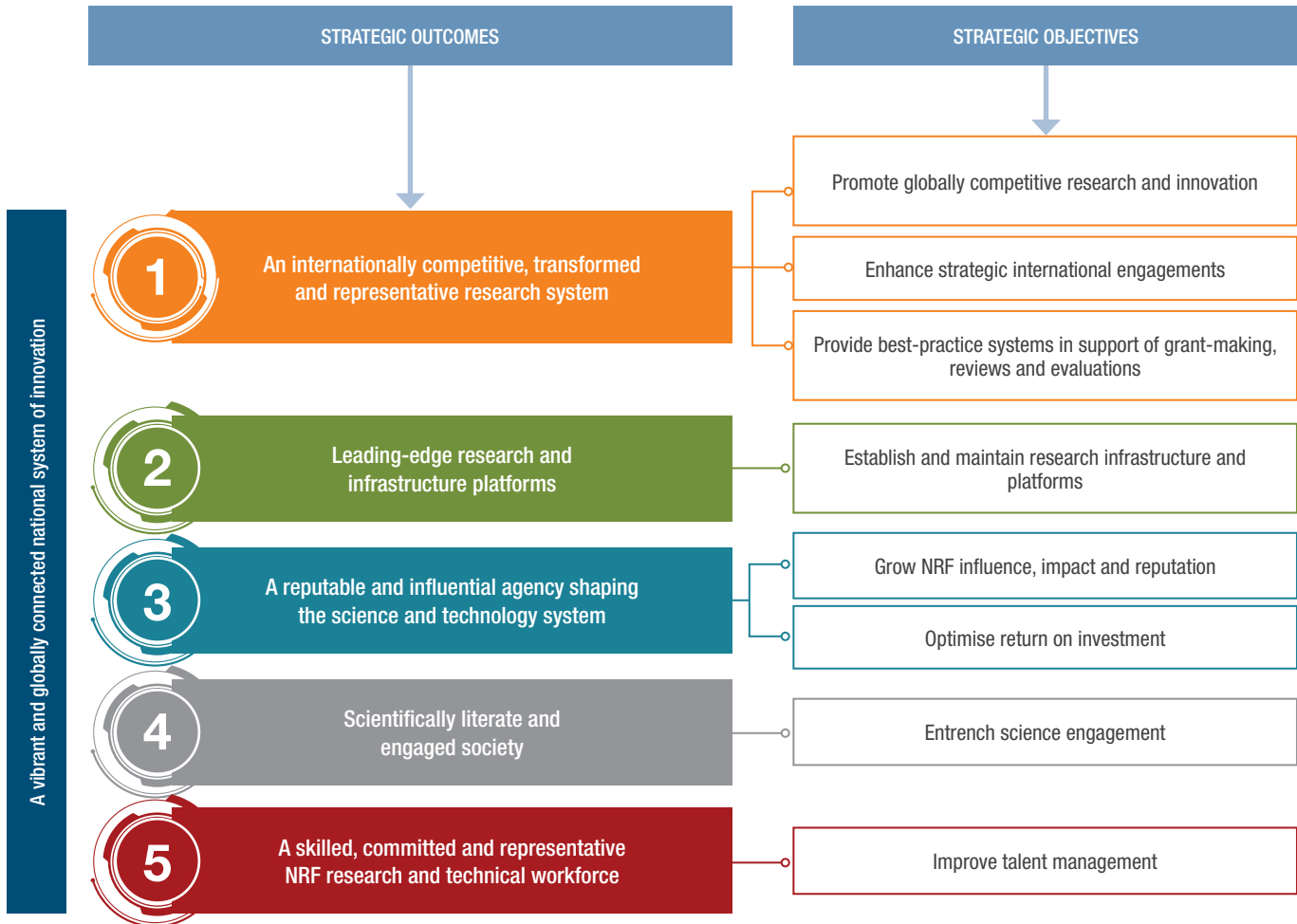
The strategic outcomes and objectives have been developed to enable the organisation to contribute to a vibrant and globally competitive and contextually relevant NSI. By virtue of its mandate, the NRF's objectives integrate seamlessly with the objectives of the DST and are complementary to the objectives of the Department of Higher Education and Training (DHET) and other government departments. The NRF outcomes are aligned to the MTSF priorities as outlined on page 108.

Figure 2: NRF values



The strategic objectives have been mapped against the five strategic outcomes as per Figure 3 and below. The NRF programmes contribute collectively or individually to all and specific objectives. Performance is aggregated across the organisation to provide a consolidated view of performance over the MTEF period.

Figure 3: NRF strategic outcomes linked to strategic objectives



4.2.4 SPECIAL INITIATIVES

The NRF has identified a number of initiatives to advance its mandate which go beyond the MTEF cycle. These include the following:

ADVANCING TRANSFORMATION PRIORITIES

The need for accelerated transformation stimulated a robust interrogation of related plans and strategies across the organisation. The NRF will intensify its response in addressing the principles of redress, the democratisation of knowledge, deepening of research excellence, social development, and the advancement of quality, effectiveness and efficiency, as well as public accountability through four dimensions of transformation. Over the MTEF period, the NRF, while acknowledging the ongoing long-term nature of the transformation effort, will continue its focus on driving:

- Transformation of the equity profiles of the South African research workforce;
- Transformation of the knowledge enterprise;
- Transformation of the relationship between science and society; and
- A fully diverse and inclusive learning organisation.

APPROPRIATE RESOURCING OF THE NRF MANDATE

The NRF parliamentary grant, which is appropriated for the delivery of the organisational mandate, is set to decrease by 0.8% in real terms for the 2018/19 financial year, while the total income is set to decrease by 20% in real terms. This will require continuous focused monitoring and managing of financial and operational sustainability. In addition, the current NRF funding model has resulted in 78% of the total budget being predetermined through contracts, leaving little room for the organisation to respond to systemic shifts in the NSI.

This model is recognised as being suboptimal for the organisation to deliver on its goals and objectives. The NRF has thus initiated a process of developing a more appropriate funding framework in consultation with the DST and National Treasury. The framework will involve a goal-orientated, performance-linked, and responsive mechanism and will also ensure increased levels of accountability through the medium- to long-term planning in support of realising national imperatives.



LEGISLATIVE AND OTHER MANDATES

5.1 SERVICE DELIVERY ENVIRONMENT AND STRATEGIC PARTNERS

The NRF works closely with universities, other research institutions, as well as public and private partners both locally and abroad. Key strategic partners include the DHET, the Department of Trade and Industry (*the dti*), all universities, and the science councils. Broader stakeholders within the NSI include the National Student Financial Aid Scheme (NSFAS), the Council on Higher Education (CHE), the National Advisory Council on Innovation (NACI), and others.

5.2 CONTRIBUTORS TO THE NRF MANDATE

The policy environment of the NRF is influenced by applicable national policy, plans, strategies as well as cross-cutting government-level policies.

5.2.1 NATIONAL STRATEGIES

The following key national plans and strategies are considered in the execution of the mandate of the NRF.

THE NATIONAL DEVELOPMENT PLAN (NDP) 2030

The NDP endeavours to "... chart a new course and write a new story" for South Africa by recognising the transformative potential of key role-players in the national system. The DST and the DHET contribute to the national vision of a technically skilled and transformed workforce, the development of a knowledge economy through the translation of basic and applied research and the development of new knowledge

that stimulates the discourse of an innovative society. Supported by the NRF, the DST and DHET aim to address the challenges of:

- Increasing the number of academic staff with doctoral qualifications from 43% to 75%;
- Increasing the number of postgraduate enrolments at higher education institutions (HEIs) from 16% to 25% or more; and
- Growing the number of doctoral graduates per annum from 2 000 to 5 000.

THE NATIONAL RESEARCH AND DEVELOPMENT STRATEGY (NRDS)

The strategy highlights the importance of globally competitive and contextually relevant research outputs in addressing the needs of the country. These are expressed through a number of geographic and knowledge advantage areas identified in the NRDS.

NATIONAL PLAN FOR HIGHER EDUCATION

The plan provides an implementation framework for realising the objectives of Education White Paper 3 on transforming the higher education system to meet the social and economic development needs of the country.

THE HUMAN RESOURCE DEVELOPMENT STRATEGY (HRDS)

The HRDS recognises the need to implement a systemic strategy for human resource development in order to address the disparities between wealth and poverty through the institutionalisation of human resource development planning and implementation, as well as the effective monitoring of progress against national targets.

5.2.2 SCIENCE AND TECHNOLOGY STRATEGIES AND POLICIES

The DST has developed a number of strategies and policies to shape the future landscape of the science system. These include:

- Ten-Year Innovation Plan of 2007;
- Strategy for Human Capacity Development for Research, Innovation and Scholarships;
- The DST Science Engagement Framework;
- The South African Research Infrastructure Roadmap (SARIR);
- The Ministerial Guidelines for Improving Equity in the Distribution of DST/NRF Bursaries and Fellowships; and
- Discipline-specific strategies and plans such as the National Strategy for Multiwavelength Astronomy, the South African Marine and Antarctic Research Strategy (MARS) and the Palaeoscience Strategy.

5.2.3 INTERNATIONAL STRATEGIES AND TREATIES

- The Science, Technology and Innovation Strategy for Africa (STISA) 2024;
- The SADC education and training protocol;
- The 2030 Agenda for Sustainable Development; and
- Agenda 2063 of the African Union.

5.3 STRATEGY IMPLEMENTATION

The NRF as public institution functions within the parameters set out by relevant legislation and applicable best practice. The NRF is committed to entrenching a culture of transparency, ethical behaviour, fiscal prudence, and accountability, thereby enhancing public trust and stakeholder assurance.

5.3.1 ACCOUNTABILITY STRUCTURE

The accountability structures of the NRF include systems through which the organisation is directed, managed and held accountable. These systems are determined by legislative policies based on the NRF Act, the Public Finance Management Amendment Act (PFMA) (Act 29 of 1999), the National Treasury Reporting Framework, the Governance Framework for Public Entities, and the South African Companies Act (Act 71 of 2008). In addition, the NRF subscribes to the requirements of the King Report on Corporate Governance for South Africa (King IV).

Parliament, through the Parliamentary Portfolio Committee (PPC) on Science and Technology of the National Assembly, maintains high-level oversight of the entity, while the Executive Authority (the Minister of Science and Technology) and the Accounting Authority (the NRF Board) are accountable for the entity. The figure below represents the accountability structure of the NRF.

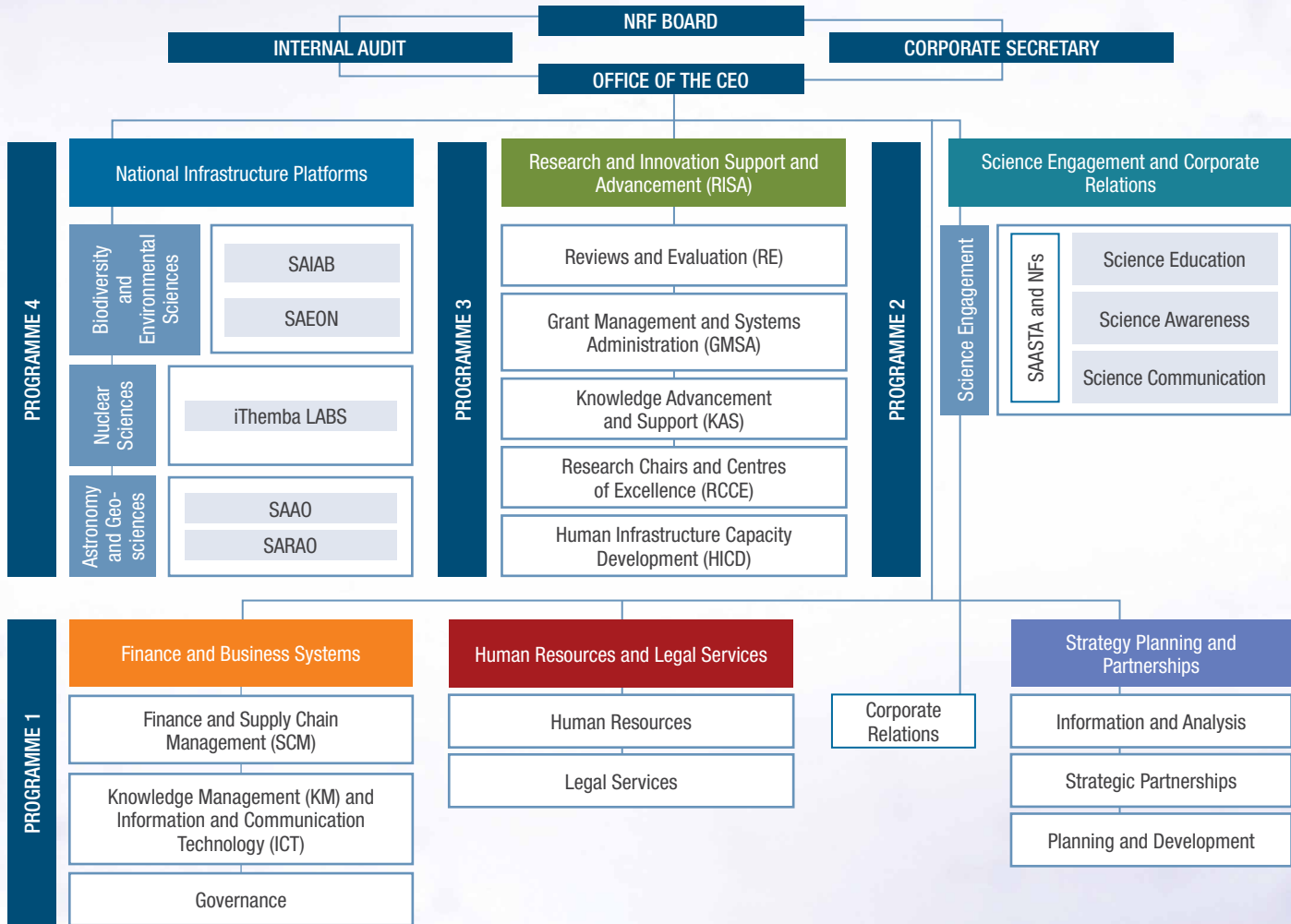
Figure 4: Accountability structure of the NRF



5.3.2 ORGANISATIONAL STRUCTURE

The organisational structure of the NRF was optimised to reflect four specific programmes that were designed to collectively and individually achieve the NRF objectives and to make the organisation fit for purpose.

Figure 5: NRF operational structure



PROGRAMME 1 – CORPORATE PROGRAMME

The Corporate Programme provides the organisation with enabling governance structures, strategy and planning capacity, and shared services through fit-for-purpose business and information systems, policies, and procedures. In addition, the programme provides strategic foresight and impact assessment both internally to the NRF and externally to the NSI – based on system-level information and data analysis.

PROGRAMME 2 – SCIENCE ENGAGEMENT

Science Engagement is an externally focused division that directs and coordinates the discourse on science in society. Through the science awareness, communication, and education initiatives, Programme 2 supports the national imperative of developing a scientifically literate society. The amendment to the NRF Act proposes NRF/SAASTA as the coordinator and implementer of the Science Engagement Framework.

PROGRAMME 3 – RESEARCH AND INNOVATION SUPPORT AND ADVANCEMENT (RISA)

RISA is a key contributor to the achievement of the NRF mandate as the granting function of the organisation. The division supports and promotes research through the development of human capacity, the generation of knowledge, and the provision of and access to cutting-edge research equipment and infrastructure.

PROGRAMME 4 – NATIONAL RESEARCH INFRASTRUCTURE PLATFORMS (NRIP)

The NRF is mandated to provide leading-edge research infrastructure platforms in support of knowledge generation, innovation and HCD. This programme incorporates the five National Research Facilities in the thematic areas of nuclear sciences, biodiversity and environmental sciences, and astronomy and geodetic sciences, access to large national and international research platforms, and research-related e-databases.

For explanations of acronyms, please refer to the list of acronyms on page 115.

5.3.3 MAJOR RISKS IN THE DELIVERY ENVIRONMENT

The NRF executive manages operational risks in accordance with the Enterprise Risk Management (ERM) Charter and related policies, informed by the Public Finance Management Act (PFMA) and the King IV Report on Corporate Governance. The Board, through the Audit and Risk Committee, actively monitors strategic risks. The following have been identified as strategic risks to monitor during the MTEF and beyond:

- An ageing research and technical workforce;
- Ageing research infrastructure;
- A suboptimal parliamentary grant relative to delivery expectations; and
- Rate of system-wide transformation.





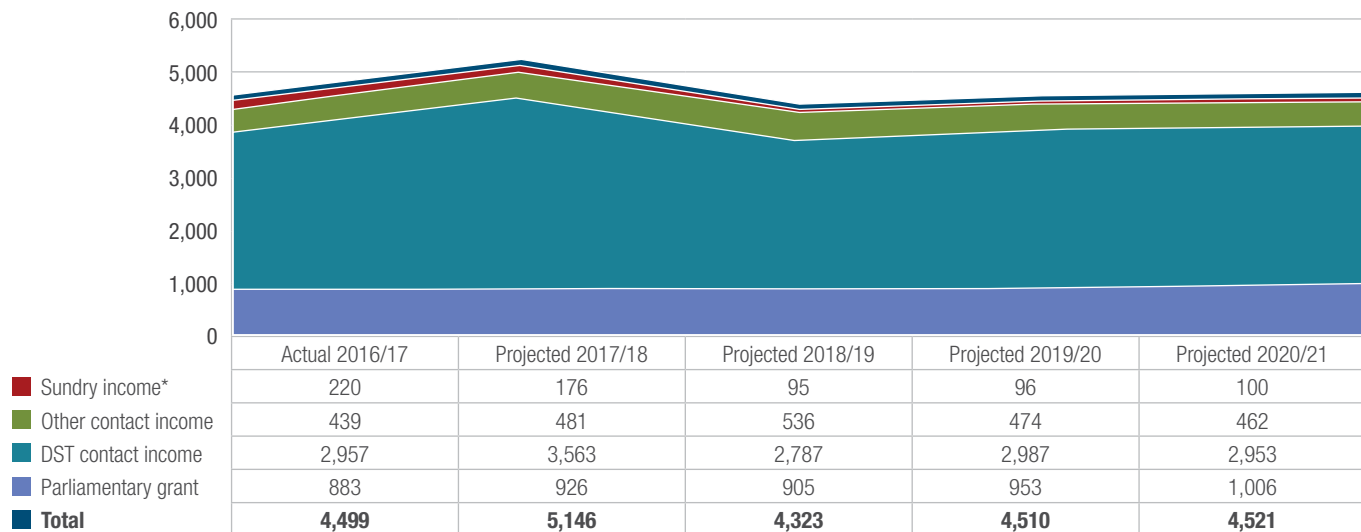
FINANCIAL OVERVIEW

The NRF primarily derives its revenue through four income streams, namely the parliamentary grant, DST contract funding, other contract funding and sundry income.

Over the MTEF period the NRF parliamentary grant, which is appropriated for the delivery of the organisational mandate, will decrease by 1% in real terms. This will require continuous focused financial monitoring and management for operational sustainability. In addition, the current NRF funding model has resulted in 78% of

the total budget being predetermined through contracts, leaving little room for the organisation to respond to systemic shifts in the NSI. This model is recognised as being suboptimal for the organisation to deliver on its goals and objectives. The NRF has thus initiated a process of developing a more appropriate framework in consultation with the DST and the National Treasury. The framework will involve a goal-orientated, performance-linked, and responsive mechanism and will also ensure increased levels of accountability through medium- to long-term planning to support realisation of national imperatives.

Figure 6: Comparison of sources of funding 2016/17-2020/21



* This includes sale of goods and services

The 2018/19 MTEF allocation excludes the National Zoological Gardens (NZG) as this National Research Facility will be transferred to the South African National Biodiversity Institute (SANBI) with effect from 1 April 2018. Total income will decrease by 14% in year one of the MTEF period in nominal terms and 20% in real terms. This decrease is related to a decrease in DST contract income carried forward from 2017/18 to 2018/19. The 2017/18 DST contract income includes R200m carried forward on the SKA project, R220m on SARChI, R75m on the NEP programme and other smaller programmes within RISA. From 2018/19 onwards, the funds carried forward are significantly lower than in 2017/18, as they are expected to remain between R100m and R200m. Approximately 60 DST contracts have been consolidated into five thematic areas/funding categories from 2018/19 onwards.

The parliamentary grant is projected to increase by an average of 5.4% year on year, in nominal terms, between the 2017/18 and the 2020/21 financial years, which is a reduction in real terms of 1% year on year. The continued decline in real terms of the parliamentary

grant will continue to be a significant risk to the sustainability of the organisation and thus necessitated management intervention in the prioritisation of initiatives. At this point, further austerity measures will start to affect the productivity of the organisation as opposed to mitigating the operational and financial sustainability risk of the organisation.

The cost of delivering on the mandate of the NRF is significantly outpacing the growth of the parliamentary grant allocation. This includes, but is not limited to, inadequate reach and value of postgraduate student bursaries, which do not increase annually in accordance with CPI. Similarly, the value and reach of grants to researchers have not increased, and in some instances have been reduced. In addition, maintenance, renewal and acquisition of necessary research infrastructure platforms and related equipment have been significantly compromised. Table 1 below is an indication of the parliamentary grant allocation split over the three-year MTEF period.

Table 1: Three-year projection of the NRF MTEF parliamentary grant allocation

Programme	NRF baseline allocation from DST (excl. NZG)	2017/18 (R million)	2018/19 (R million)	2019/20 (R million)	2020/21 (R million)
3	RISA	469 429	483 612	509 587	537 494
4	National Research Facilities	278 442	288 613	304 102	320 946
2	Science Advancement	23 503	25 022	26 366	27 817
4	SAEON	11 658	12 253	12 914	13 624
1	Corporate Services	77 081	95 252	100 396	105 918
	Total NRF Parliamentary Grant (Baseline Allocation)	860 113	904 752	953 365	1 013 814
	Year-on-year baseline movement	4,9%	5,2%	5,6%	5,5%

Table 2 below is an indication of the contract allocation from DST split over the three-year MTEF period.

Table 2: Three-year projection of the NRF MTEF contract funding allocation

Programme	NRF contract income allocation from DST (excl. NZG)	2017/18 (R million)	2018/19 (R million)	2019/20 (R million)	2020/21 (R million)
2	Science Awareness	60 197	57 006	62 579	62 579
3	Human Resource Development	731 351	1 397 703	1 502 943	1 578 472
3 & 4	Research Development Infrastructure	332 026	161 960	321 697	158 420
3 & 4	Science Missions	144 299	222 772	239 116	249 877
4	Square Kilometre Array (SKA) project	693 931	709 412	769 800	812 139
	Total MTEF contract income allocation	1 961 804	2 548 853	2 896 135	2 861 487

Other contract income includes contracts with other government departments and entities, private companies as well as international organisations, including the Department of Higher Education and Training, the Department of Trade and Industry and the Department of Agriculture, Forestry and Fisheries. This allocation is projected to decrease by 1% over the MTEF period.

Sundry income consists mainly of interest earned and income generated through the sale of isotopes at iThemba LABS.

6.1 NRF INVESTMENT PRINCIPLES

The demand for research funding far exceeds the funding available to the system. The NRF continuously assesses and implements the most efficient and effective investment decisions with the limited parliamentary grant of R905 million, which constitutes 21% of the total income. The organisation applies a set of principles to guide its investment decisions across the range of its interventions, functions, facilities, and programmes.

The NRF allocates available resources:

- To support achievement of the organisational mandate which includes transformation of the NSI;
- In alignment with the rolling operational and financial sustainability plan;
- In accordance to the core principles of equity, fairness, transparency and accountability;
- Informed by rigorous quality peer review that applies to all grant and bursary funding applications; and
- In alignment with a balanced strategy-driven approach, rather than a demand-pull approach.

6.2 SAVINGS AND EFFICIENCY MEASURES

Over the years, the NRF has designed and implemented various austerity measures in an attempt to be fiscally prudent and improve operational efficiencies. Such measures are deliberately intended not to compromise the execution of the core mandate of research support. In this regard, travel has been reduced in lieu of video-

conferencing, the use of transversal contracts as a cost-effective procurement modality, leveraging off economies of scale through demand management, increased use of owned versus leasehold office space, and the introduction of an integrated enterprise-wide performance management system, including rigorous implementation of the National Treasury's cost-containment measures.

Management recognises the fine line between effective austerity measures and optimal productivity. In this regard, there is a concern that further austerity measures will start to erode the effectiveness of the organisation.

6.3 DETAILED BUDGETS AND EXPENDITURE

Detailed NRF budgets have been prepared, taking into account all sources of income and with due regard for efficiency savings and operational effectiveness. The NRF will support on average 3 275 researchers per year over the MTEF, of whom approximately 2 176 will be black, and 2 001 will be female. Postgraduate bursaries will

be awarded to more than 15 000 postgraduate and postdoctoral students per year, of whom an average of 9 500 will be black and 7 323 will be female. Equipment will be funded to the value of R900 million over the MTEF, to which an average of 2 200 research users will have access per year. The National Research Facilities will provide support to more than 600 postgraduate students, and produce up to 430 Web of Science publications per annum with a combined citation impact of 1.25 and higher. It is expected that an average of 2 600 research users will access the facilities each year. To enhance the relationship between science and society, the investment in science engagement activities at SAASTA and the National Research Facilities will enable the reach of an average of 1.08 million members of the public, 2 900 educators, and 220 000 learners per year.

Table 3 presents the abridged budget of the NRF for the 2017/18 financial year, and Table 4 provides a summary of the projected financial statements for the MTEF period 2018/19 – 2020/21 aligned with the annual plans. Table 5 represents the summary of projected expenditure per programme for the year.



Table 3: Abridged financial report for the year ending 31 March 2019

BUDGET 2018/19	Programme 1	Programme 2	Programme 3	Programme 4							TOTAL 2018/19	Consolidated budget (excl. internal transfers) 2018/19	Consolidated budget (excl. internal transfers) 2017/18
	Corporate	Science Engagement	RISA	BIODIVERSITY, ENVIRONMENTAL, CONSERVATION & NUCLEAR SCIENCES NATIONAL FACILITIES				ASTRONOMY & GEODETIC SCIENCES NATIONAL FACILITIES					
				Dep CEO: Facilities	ITHEMBA	SAIAB	SAEON	SKA	SAAO	HartRAO			
R'000	R'000	R'000	R'000	R'000	R'000	R'000	R'000	R'000	R'000	R'000	R'000	R'000	R'000
Budgeted unspent funds/(deficit) at beginning of year	-	-	-	-	-	-	-	-	-	-	-	-	431
MTEF allocation - Baseline	95,252	25,022	483,612	6,664	179,825	19,209	12,253	-	54,332	28,583	904,752	904,752	925,964
MTEF allocation - DST contract income	4,000	57,006	1,649,678	4,220	25,283	8,300	81,050	710,412	8,904	-	2,548,853	2,548,853	1,961,804
DST contract income carried forward	-	-	110,846	-	-	1,472	(19,424)	144,942	-	-	237,836	237,836	912,173
Other contract income	4,577	29,291	424,015	-	209	4,080	5,921	36,313	28,540	2,665	535,611	535,611	1,170,232
Interest received	4,000	3,451	8,310	-	3,981	2,399	700	-	606	890	24,337	24,337	46,064
Internal income	22,564	-	-	-	27,733	28,131	19,845	-	33,181	19,839	151,293	-	-
NZG entrance fees	-	-	-	-	-	-	-	-	-	-	-	-	44,959
Retail and other sales	-	850	-	-	61,910	16	-	-	2,218	65	65,059	65,059	77,289
Other income	-	1,664	-	-	1,355	137	-	818	1,215	80	5,269	5,269	7,929
Total income	130,393	117,284	2,676,461	10,884	300,296	63,744	100,345	892,485	128,996	52,122	4,473,010	4,321,717	5,146,845
Grants and bursaries	-	(45,130)	(2,371,013)	(4,220)	(3,000)	(4,341)	(3,843)	(72,987)	(2,058)	(1,432)	(2,508,024)	(2,508,024)	(2,776,663)
Infrastructure maintenance, programme and operating expenses	(45,576)	(39,913)	(75,856)	(1,478)	(126,182)	(24,936)	(34,398)	(375,144)	(47,912)	(17,107)	(788,502)	(788,502)	(858,824)
Internal expenses	(750)	(4,042)	(123,284)	-	(8,220)	(602)	(352)	(10,509)	(2,344)	(1,190)	(151,293)	-	-
Salaries	(81,024)	(29,623)	(114,318)	(5,076)	(158,382)	(26,639)	(42,816)	(241,503)	(69,526)	(22,986)	(791,893)	(791,893)	(766,768)
Total expenditure	(127,350)	(118,708)	(2,684,471)	(10,774)	(295,784)	(56,518)	(81,409)	(700,143)	(121,840)	(42,715)	(4,239,712)	(4,088,419)	(4,402,255)
Net unspent funds/(deficit) for the year	3,043	(1,424)	(8,010)	110	4,512	7,226	18,936	192,342	7,156	9,407	233,298	233,298	744,590
Transfer from Infrastructure fund	-	-	-	-	-	-	-	-	-	-	-	-	9,998
Capital expenditure	(3,043)	(182)	(6,480)	(110)	(29,431)	(16,585)	(21,945)	(274,592)	(17,072)	(13,639)	(383,079)	(383,079)	(897,069)
Non-cash flow items – depreciation	-	1,606	14,490	-	24,919	9,359	3,009	82,250	9,916	4,232	149,781	149,781	142,481
Unspent funds/(deficit) at end of the year	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 4: Abridged projected financial statements for the MTEF period (2018/19–2020/21)

STATEMENT OF FINANCIAL PERFORMANCE			
CATEGORY	2018/19 Projected	2019/20 Projected	2020/21 Projected
	R'000	R'000	R'000
Government grant – Baseline	904,752	953,365	1,005,799
DST contract income	2,786,689	2,986,844	2,953,431
Other contract income	535,611	474,396	462,213
Interest received	24,337	21,946	22,352
Other income	70,328	73,943	77,703
Total income	4,321,717	4,510,494	4,521,498
Grants, bursaries and other research	2,508,024	2,868,926	2,813,433
Infrastructure maintenance, programme and operating expenses	788,502	869,760	911,227
Human capacity of National Facilities, Programmes and Operations	791,893	813,689	868,777
Total expenditure	4,088,419	4,552,375	4,593,437
Income set aside for capital acquisitions	233,298	(41,881)	(71,939)
Less: Net capital expenditure	(233,298)	41,881	71,939
Net budgeted unspent funds for the year	-	(0)	-
Opening accumulated fund	-	-	-
Accumulated funds for the year	-	(0)	-

STATEMENT OF FINANCIAL POSITION			
CATEGORY	2018/19 Projected	2019/20 Projected	2020/21 Projected
	R'000	R'000	R'000
Property, plant & equipment, Intangible assets and Heritage assets	1,956,959	1,915,078	1,843,139
Inventory	3,350	3,300	3,200
Receivables & prepayments	877,500	847,400	835,000
Cash & investments*	520,000	420,000	400,000
Total assets	3,357,809	3,185,778	3,081,339
Accumulated fund & SALT fund	18,447	18,447	18,447
Capital fund & Infrastructure fund	2,023,027	1,981,146	1,909,207
Income received in advance	1,225,095	1,096,395	1,066,185
Payables & provisions	91,240	89,790	87,500
Total liabilities	3,357,809	3,185,778	3,081,339

* Cash holdings represents commitments for designated programmes and projects.

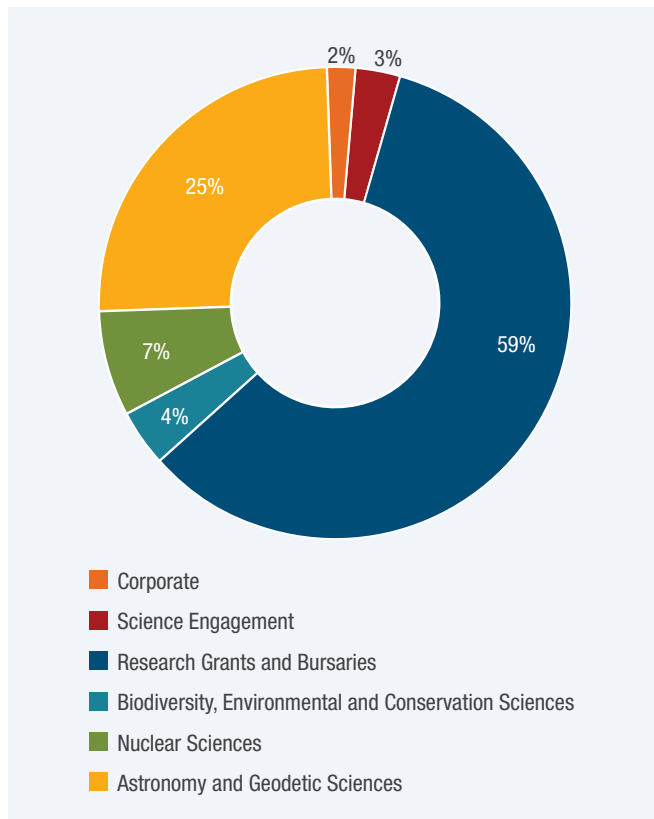
Table 5: Projected expenditure report per programme for the year ending 31 March 2019

CATEGORY	Programme 1	Programme 2	Programme 3	Programme 4		TOTAL
	Corporate	Science Engagement	RISA	Biodiversity, Environmental & Nuclear Sciences	Astronomy & Geodetic Sciences	
	R'000	R'000	R'000	R'000	R'000	
Grants and bursaries	-	46,239	2,370,514	15,388	75,883	2,508,024
Infrastructure maintenance, programme and operating expenses	45,576	46,853	75,857	185,318	434,898	788,502
Internal expenses	750	4,042	123,283	9,174	14,044	151,293
Salaries	81,024	42,641	114,319	227,856	326,053	791,893
Net capital expenditure	3,043	(1,307)	(8,006)	30,776	208,792	233,298
Total expenditure	130,393	138,468	2,675,967	468,512	1,059,670	4,473,010



Figure 7 below is a graphical representation of the distribution of projected expenditure across the organisation in the 2018/19 financial year. Research grants and bursaries account for 59% of the total NRF expenditure, which is invested at universities through various funding instruments. The SKA SA project will deliver the full 64-dish array by March 2019.

Figure 7: Total projected expenditure including capital 2018/19



Financial analysis, risks and impacts

Considering that the National Research Facilities are largely funded from the parliamentary grant, the decrease in the grant in real terms negatively impacts the performance and sustainability of the National Research Facilities. The real risk is to the productivity of the National Facilities where, over the MTEF period, the real reduction in budgets will start to impact research productivity. The fluctuation and volatility of the rand further impacts negatively on the business of the NRF particularly with regard to the procurement of specialised imported materials and equipment. The facilities are also unable to renew their research workforce or renew, replace or acquire necessary research infrastructure.

Capital expenditure declines significantly in 2018/19 with the final commissioning of the MeerKAT arrays. Thereafter, capital expenditure is provided at a bare minimum in order to maintain operations only, thus no scope for expansion, in line with funding. Grants, bursaries and other research support are directly linked to the movement in funding and subsequently to movements in performance targets. This expenditure has remained fairly stable, except for the major movement in the allocation for scientific equipment (refer income section), for which no funding was allocated in the 2018/19 and 2020/21 financial years (funding in 2017/18 amounted to R181m). Operating expenditure in 2018/19 remained constant in line with inflationary increases. An estimate for the operating funds for MeerKAT, post full science commissioning, has been included from 2019/20.

Employee remuneration increased in line with a cost-of-living adjustment.

Abridged projected financial statements (2017/18–2020/21)

(page 26) provides a summary of the projected financial statements for the 2017/18 – 2020/21 period aligned with the annual plans.

Table 6: Long-term infrastructure and other capital plans (2018/19–2020/21)

No	Business division	Description	Outputs	Estimated project costs	Project duration		2016/17	2017/18	2018/19	2019/20	2020/21	Additional infrastructure/capital
				R'000	Start	Finish	R'000	R'000	R'000	R'000	R'000	
1.	National Facilities	Upgrade and replacement of scientific equipment	Access to state-of-the-art research equipment and facilities	N/A	Based on ongoing review and availability of funds		175,058	215,452	98,782	43,780	32,765	
2.	SAASTA	Computer and office equipment	Enhanced working environment to enable delivery on various contract projects	N/A			2,304	1,137	182	214	144	Pending a national strategy on science advancement, the SAASTA Johannesburg Observatory site may require R60 million to upgrade.
3.	RISA	Computer, office equipment and building refurbishment	Enhanced working environment and improved efficiency	N/A			2,768	5,317	6,480	6,070	6,025	
4.	Corporate	Computer, office equipment and building construction	Enhanced working environment and improved efficiency	N/A			18,351	12,815	3,043	1,578	239	
5.	SKA project	Construction of KAT7 and MeerKAT comprising 64 radio antennae	World-class telescope for many years based on mission-driven innovation enabling South Africa to undertake cutting-edge research into deep space	3,700,000	2002/03	2017/18	429,946	662,348	274,592	67,413	59,553	
							628,427	897,069	383,079	119,055	98,726	

Additional infrastructure and capital plans

The additional infrastructure and capital plans are dependent on the approval of additional funding by National Treasury. The additional plans will only be initiated and implemented once the MTEF submission has been done and approval thereof received.



NRF RESPONSE TO NATIONAL STRATEGIES AND PLANS

The NRF responds to the priorities and strategies of government through supporting research, human capacity development, platform provisioning, and science engagement in all knowledge fields.

7.1 CONTRIBUTING TO THE NATIONAL DEVELOPMENT PLAN (NDP) 2030 – MTSF PRIORITY OUTCOMES

The goals and objectives of the NRF align to the outcomes of the NDP 2030 (MTSF Priority Outcomes). For a detailed alignment of NRF strategic outcomes to the NDP and the DST outcomes please refer to page 15. The NRF aims to support the creation of a diverse and socially cohesive society by facilitating a discourse between science and society that underpins the commitment that publicly-funded research should be to the betterment of society. In this respect, knowledge creation and dissemination become integral components of the strategy towards a knowledge economy.

The NRF supports students from postgraduate through to established researcher level through the provision of grants, bursaries, scholarships and fellowships, as well as professional development programmes for research and instructional staff at HEIs and staff within the NRF. The targeted strategic investments in areas of social relevance ensure that the contribution to the national knowledge base informs solutions to social challenges and benefits society. An ongoing challenge is the need to significantly increase the reach and the value of bursaries

and scholarships as well as the reach and value of research grants to postgraduate students and researchers respectively.

The doctoral degree is the entry level qualification into a research and innovation career. During 2016 the country produced 2 797 doctoral graduates of which approximately 35% were supported by the NRF during their studies. This is achieved even though the NRF provides financial support to less than 18% of all registered doctoral students on average.

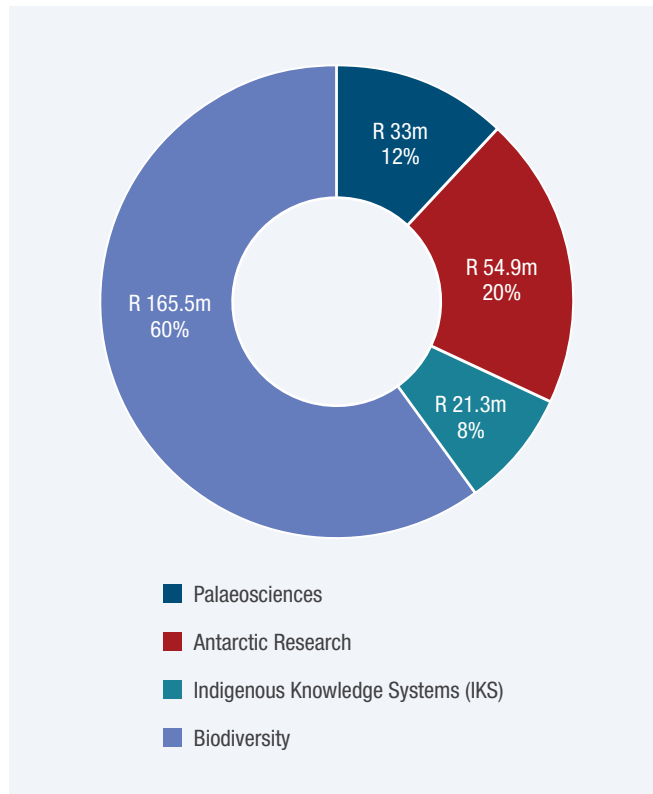
7.2 THE NATIONAL RESEARCH AND DEVELOPMENT STRATEGY (NRDS)

The NRDS highlights the importance of globally competitive and contextually relevant research outputs in addressing the needs of the country. Human capacity development and knowledge generation in strategic domains, are the key outcomes of the strategy. The domains are expressed through the geographic and knowledge advantage areas, which are Palaeosciences; Antarctic Research; Indigenous Knowledge Systems related to southern Africa; Biodiversity; and Astronomy.

Over the MTEF period, the NRF will invest R824 million in the area of the geographic and knowledge advantage areas (excluding Astronomy). This represents an average nominal increase of 3% year on year over the MTEF period. In real terms this is a decrease of 4%. To date, five

Centres of Excellence (CoEs) and 38 SARChI research chairs have been established in geographic advantage areas (excluding Astronomy). The investment trends and budget estimates for these particular advantage areas (excluding Astronomy) are represented in Figure 8.

Figure 8: Average investment in the geographic advantage areas 2018/19 – 2020/21





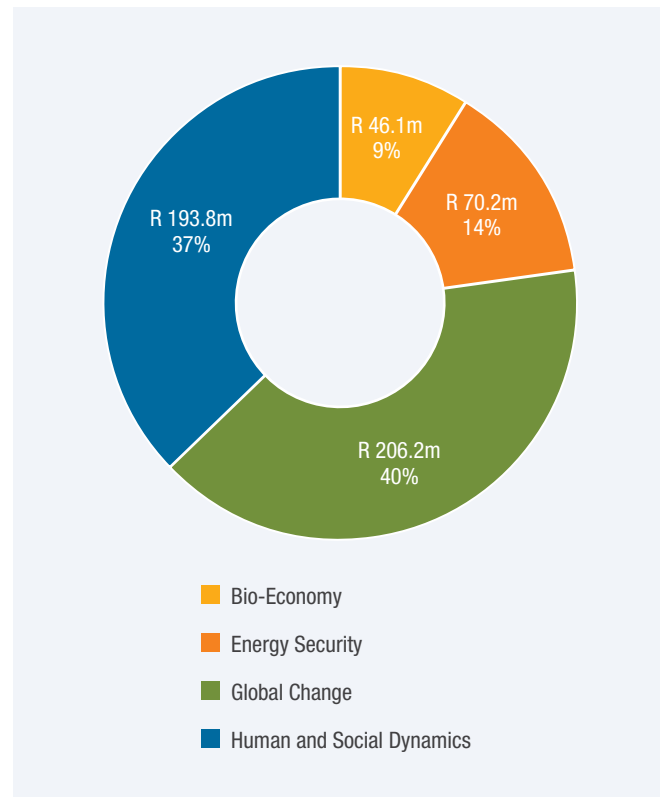
7.3 TEN-YEAR INNOVATION PLAN (TYIP)

The TYIP utilises the knowledge and human capacity developed through science and technology research to enhance socio-economic benefits. The plan identifies five grand challenges, namely the bio-economy; energy security; global change; human and social dynamics; and astronomy. The key principles of the plan are to:

- Support strategic decision-making to enable government to make informed decisions;
- Pursue competitive advantage – ensuring that investment is made in areas with the highest return;
- Create critical mass – so the investment strategy should support the creation of critical mass in high-yield areas; and
- Scale up sustainable research and development.

Over the three years from April 2014 to March 2017, the NRF invested R1.21 billion in the grand challenges excluding Astronomy. A further R1,55 billion will be invested over the MTEF period (2018/19 to 2020/21). This represents an average decrease of 2% in nominal terms and an 8% decrease in real terms. To date, nine CoEs have been established in support of the grand challenges, and 88 research chairs have been awarded in the areas of bio-economy, energy security, and global change. Over the last three years, more than 3 000 students were supported at postdoctoral level through these strategic instruments. Figure 9 indicates the investment in the grand challenges. Astronomy is recognised as both a grand challenge (space science) and a geographic advantage area and is discussed in detail in section 7.4.

Figure 9: Average investment in the grand challenges (excluding Astronomy) 2018/19 – 2020/21





7.4 ASTRONOMY AND GEODETIC SCIENCES

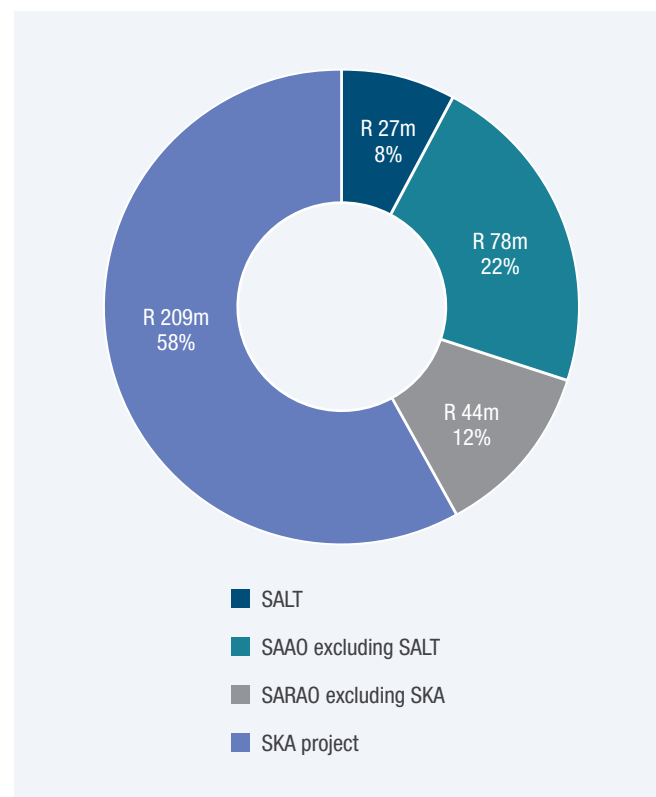
Astronomy is classified under geographic advantage in terms of the NRDS and is a grand challenge in terms of the TYIP. The NRF provides research grants, and student bursaries and scholarships in this area, and supports two National Research Facilities namely the South African Astronomical Observatory (SAAO) and the South African Radio Astronomy Observatory (SARAO).

Figure 10 is an indication of the average investment in optical and radio astronomy from 2016/17 – 2020/21.

Over the MTEF period, the total investment will amount to R446 million, which includes R160 million for human capacity development through targeted initiatives such as the National Astrophysics and Space Science Programme (NASSP) and SARChI. Due to the nature of the SKA project and the large investment required, the projected funding is discussed in the next paragraph.

Since 2008, the government has invested R3,4 billion in the SKA SA project including the construction of the MeerKAT radio telescope array. For the SKA-SA project there is a budgeted amount of R628 million over the MTEF, an average of R209 million per year.

Figure 10: Average investment in Astronomy 2016/17 – 2020/21





PART B:
PROGRAMME
PLANS



PROGRAMME 1 – CORPORATE

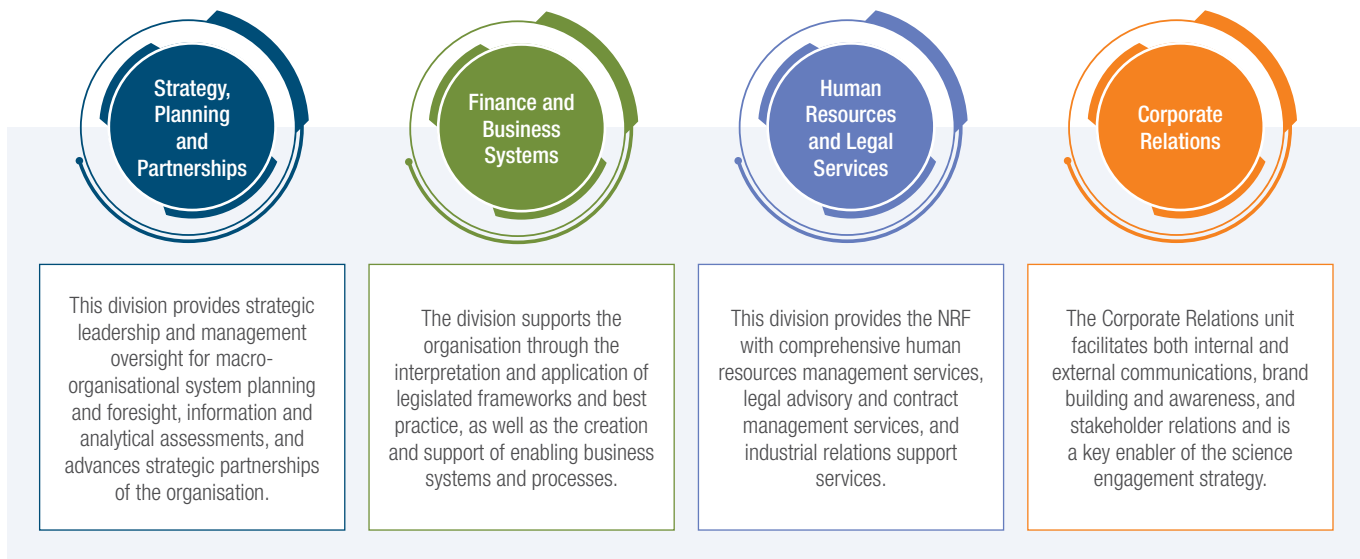
8.1 SITUATIONAL ANALYSIS

The key objective of Programme 1 is the provision of cross-cutting support functions to enable operations of the organisation on a shared services model. The programme sets the tone for organisational strategy, policy, planning, information sharing and good governance in assuring statutory compliance and execution of the mandate.

8.2 CONTRIBUTIONS TO STRATEGIC OBJECTIVES

Programme 1 directly contributes to Strategic Objectives 5 and 6, and indirectly to all other objectives through its cross-cutting mandate. Programme 1 consists of the four divisions as shown in Figure 11.

Figure 11: Programme 1 – Corporate



8.2.1 STRATEGIC OBJECTIVE 5: GROW NRF INFLUENCE, IMPACT AND REPUTATION

In order to contribute successfully to Strategic Objective 5, the programme must:

- Provide system-level intelligence that informs organisational and national policy and strategy;
- Facilitate and lead policy development, system-wide planning, and the periodic monitoring and evaluation of their implementation;
- Communicate science and research achievements;
- Build the NRF brand through proactive leadership, consistent service excellence and stakeholder relations; and
- Leverage off the NRF reputation through strategic public and private partnerships in support of the execution of the NRF mandate.

PROMOTE STRATEGIC ENGAGEMENTS AND PARTNERSHIPS LOCALLY AND INTERNATIONALLY

The Strategy, Planning and Partnerships (SPP) Business Unit has as its key responsibility cultivating, sustaining and expanding strategic partnerships of the NRF both locally and internationally, with the public and private sector, and civil society, to support the NRF's mandate. SPP supports the NRF mandate and priorities such as the transformation of the research system through the leveraging of additional resources to drive the system (both mutual benefit and financial investments); forging networks and partnerships with government, the private sector, research performing institutions, development partners and other stakeholders; and positioning of the organisation as a partner of choice.

PROVIDE SYSTEM-LEVEL INTELLIGENCE

The SPP Business Unit provides the NRF with systemic information and data analytics for operational, planning and strategic purposes, through the creation and accessing of a data warehouse, including the management of organisational intelligence and analytical systems.

Using its stable, sustainable, and scalable business intelligence platforms, the SPP extracts, integrates, interprets and analyses relevant data to respond to the needs of NRF and its NSI partners. SPP contributes to growing the influence, impact and reputation of the NRF by providing robust and credible evidence to support and inform decision-making processes and improve systems, structures and policies both internally and in the NSI.

PLANNING AND DEVELOPMENT

The SPP Business Unit provides strategic leadership and management oversight for macro-organisational system planning and foresight. Informed by evidence, which sometimes emanates from the Information and Analysis Directorate, SPP provides macro-organisational policy development, long-term planning, including monitoring and evaluating the implementation of the policies. SPP works in concert with all business units of the NRF to lead thought processes on strategic policy formulation to support the delivery of the NRF mandate. A priority in supporting the *NRF Strategy 2020*, are the initiatives that realise the organisation's transformation agenda.

BUILD A POSITIVE REPUTATION FOR THE NRF AND COMMUNICATE SCIENCE AND RESEARCH ACHIEVEMENTS

The Corporate Relations function is responsible for communications within the NRF, which includes communicating science and research achievements to society. Over the MTEF period, the NRF Corporate Relations unit will launch a number of focused strategic initiatives and sustain other initiatives launched in preceding years. These initiatives include:

- Brand Positioning and Partnership Campaign. The branding and communication strategy was approved in the 2016/17 financial year. Over the MTEF period, the implementation of the strategy will prioritise the support of strategic partnerships with private and public entities.

- Building brand ambassadorship (“One NRF”). Over the MTEF period the Corporate Relations unit will partner with relevant stakeholders to devise and launch a programme aimed at building an organisational culture and orientation centred on the principle of the “One NRF” brand ambassadorship.
- Science-society interactions. The Science for Society lectures/series provide a successful platform for the communication of research and engagement with public audiences. The initiative has grown over the last few years and currently enjoys positive partnerships with scientists and researchers as well as participating higher education institutions and science councils. Over the MTEF, the NRF will continue to explore avenues to increase its reach and

introduce additional formats and categories of speakers, which may involve the inclusion of Nobel laureates and other scientists of stature in the speaking engagements. This will be explored in partnership with Programme 3. As part of the unit’s research communication strategy the following will be undertaken:

- A fortnightly blog called “ Science Matters” will be published;
- Six Science for Society lectures/Science and Cocktails, or any other events to which the public is invited to engage with scientists about their research; and
- Publication of a compendium of research communication stories.

Table 7: Programme 1 – KPIs against budget (2018/19–2020/21) – Strategic Objective 5

	Strategic Objective 5	Grow NRF influence, impact and reputation
	Objective Statement	Contribute to building the NRF brand through the provision of consistently excellent customer-centered service offerings.
	Critical Implementation Activities	<ul style="list-style-type: none"> • Provide system intelligence that informs strategy and policy; • Communicate science and research achievements (including Mzansi for Science); • Build NRF brand through partnerships and service excellence; and • Leverage off the NRF reputation through strategic public, private sector, and international partnerships.
	Links to MTSF	NRF Objective 5 links to: <ul style="list-style-type: none"> • MTSF Priorities 11 and 14.

INDICATORS	Actual 2015	Actual 2016	Actual 2017	Target 2018	Proj. 2019	Proj. 2020	Proj. 2021
Multimedia coverage items	89	125	87	110	130	150	150
Number of internal and external users of the NRF business intelligence systems	*	50	74	70	150	160	160
BUDGET (R million)	Actual 2015	Actual 2016	Actual 2017	Target 2018	Proj. 2019	Proj. 2020	Proj. 2021
Corporate Relations	9,243	10,532	8,737	14,204	11,754	9,700	9,762

*KPI implemented in 2016.

8.2.2 STRATEGIC OBJECTIVE 6: OPTIMISE NRF RETURN ON INVESTMENT

In order to contribute successfully to Strategic Objective 6, Programme 1 provides a system of shared services to all the business units – allowing the NRF, efficiently and effectively, to:

- Promote good governance as a strategic asset;
- Provide leading-edge business systems and operational processes; and
- Provide effective combined assurance to the accounting and executive authorities.

PROMOTE GOOD GOVERNANCE

A. Corporate Governance

The Governance directorate is responsible for the establishment and support of internal structures and processes within the control environment of the business, to enable the officers and directors of the organisation to discharge their duties effectively. Refer to pages 112 and 113 for a summary of the key legislation and codes of best practice applicable to the operations of the NRF.

The Governance directorate consists of a number of compliance and assurance-based business units that support an enabling structure against which the organisation maintains and measures its compliance in terms of regulations and best practice.

Over the MTEF period, the directorate will:

- continue to prioritise the principles of good corporate governance in order to support compliance and respond to shifts in the system of binding and non-binding rules applicable to the public entity;
- adopt a consistent and appropriate approach to the application of safety, health and the environment with respect to principles, policies and procedures across the business to support the combined assurance process;
- continue to translate statutory reporting requirements and integrate these with business processes in order to support a meaningful

planning process while ensuring that organisational reporting remains a value-add at all levels; and

- continue to provide an advisory service to the business units of the NRF to ensure that governance remains a strategic asset.

B. Corporate Finance

The mandate of the Corporate Finance unit includes the management and control of the financial processes of the organisation through the provision of business systems, management accounting support, policy development, financial change management, statutory reporting, work-flow development and financial control. The unit provides the frameworks, tools and systems that enable prudence, optimisation and accountability. They do not do it themselves, the organisation's staff and structures do.

Over the MTEF period the NRF will continue to meet all the statutory obligations of a schedule 3A public entity. The NRF is committed to the achievement of an unqualified audit opinion annually. The office of the Auditor-General of South Africa introduced the Clean Audit Outcome which is achieved through the submission of:

- Financial statements that are free from misstatements (unqualified audit opinion);
- No material finding on the audit of predetermined objectives; and
- No non-compliance with legislation.

C. Supply Chain Management (SCM)

SCM has been identified as a strategic priority across the public sector. To this end, enterprise-wide demand management has the potential to reduce operational costs. The SCM function initiates legislative processes after adopting a risk and change management approach, appropriate to the timing and nature of implementation.

Over the MTEF period, the unit will:

- Support the execution of the organisational demand plan in line with National Treasury regulations;

- Support business units with procurement matters; and
- Administratively support the Bid Award Committee (BAC) with bid management processes.

Other priorities include the annual verification of the Broad-Based Black Economic Empowerment (BBBEE) rating of the NRF as well as the integration of government's Central Supplier Database (CSD) to the NRF's financial system, and the roll out of the workflow system.

PROVIDING LEADING-EDGE INFORMATION COMMUNICATION TECHNOLOGY (ICT)

A. Provide ICT systems to support effective and efficient operations

The ICT unit strives to be an efficient and effective support service to the organisation and prioritises the principles of good governance, accountability, and service excellence. Through the retention of skilled and committed staff, the unit will continue to offer stable, sustainable, scalable, and relevant IT support systems in the 2018/19 financial year. Over the MTEF period, the unit will implement changes as needed to ensure:

- A fit-for-purpose service offering;
- Appropriate levels of innovation and support;
- Proactive support in dealing with IT security and cybercrime risks;
- Redundancy and security of ICT assets as appropriate and available, in line with recovery time objectives; and
- Continuous improvement of internal stakeholder communications.

B. Knowledge management

Knowledge management is a cross-cutting compliance function aimed at ensuring that the NRF adheres to legislation and best practice on information security and management.

Over the MTEF period the function will:

- Continue to drive compliance through the roll-out of the electronic records and document management system;

- Support the digital preservation of the NRF's institutional heritage according to the approved guidelines;
- Continue to support Open Access as it is interpreted across the organisation and in the wider NSI context; and
- Provide support for various e-databases and e-resources in consultation with Programme 4.

PROVIDE EFFECTIVE COMBINED ASSURANCE

The customised combined assurance model for the NRF ensures optimal coverage to management and to internal and external assurance providers on the day-to-day risks facing the organisation. The coordination of the combined assurance model will continue to be an area of priority within the Governance directorate over the MTEF period.



Table 8: Programme 1 – KPIs against budget (2018/19–2020/21) – Strategic Objective 6

Strategic Objective 6	Optimise return on investment
Objective Statement	Design and implement customised enabling support systems based on compliance.
Critical Implementation Activities	<ul style="list-style-type: none"> Promote good governance as a strategic asset; Provide leading-edge ICT systems to support efficient and effective operations; and Provide effective combined assurance.
Links to MTSF	NRF Objective 6 links to: MTSF Priority 4 – Decent employment through inclusive growth through the promotion of governance and compliance as a strategic asset, and drives compliance with respect to Broad-Based Black Economic Empowerment and the Industrial Policy Action Plan (IPAP).

INDICATORS	Actual 2015	Actual 2016	Actual 2017	Target 2018	Proj. 2019	Proj. 2020	Proj. 2021
Corporate overheads: calculated as a percentage of total expenditure	2.2%	1.4%	<3%	<3%	<3%	<3%	<3%
Organisational overheads: calculated as a percentage of total expenditure	7,5%	5.5%	<10%	<10%	<10%	<10%	<10%
Investment in ICT platforms	11,570,169	11,836,704	14,485,600	13,802,508	15,757,935	18,228,815	19,44,2070

BUDGET (R million)	Actual 2015	Actual 2016	Actual 2017	Target 2018	Proj. 2019	Proj. 2020	Proj. 2021
NRF Corporate	87,644	131,349	107,258	86,427	112,954	121,904	127,662

8.2.3 STRATEGIC OBJECTIVE 8: IMPROVE NRF TALENT MANAGEMENT

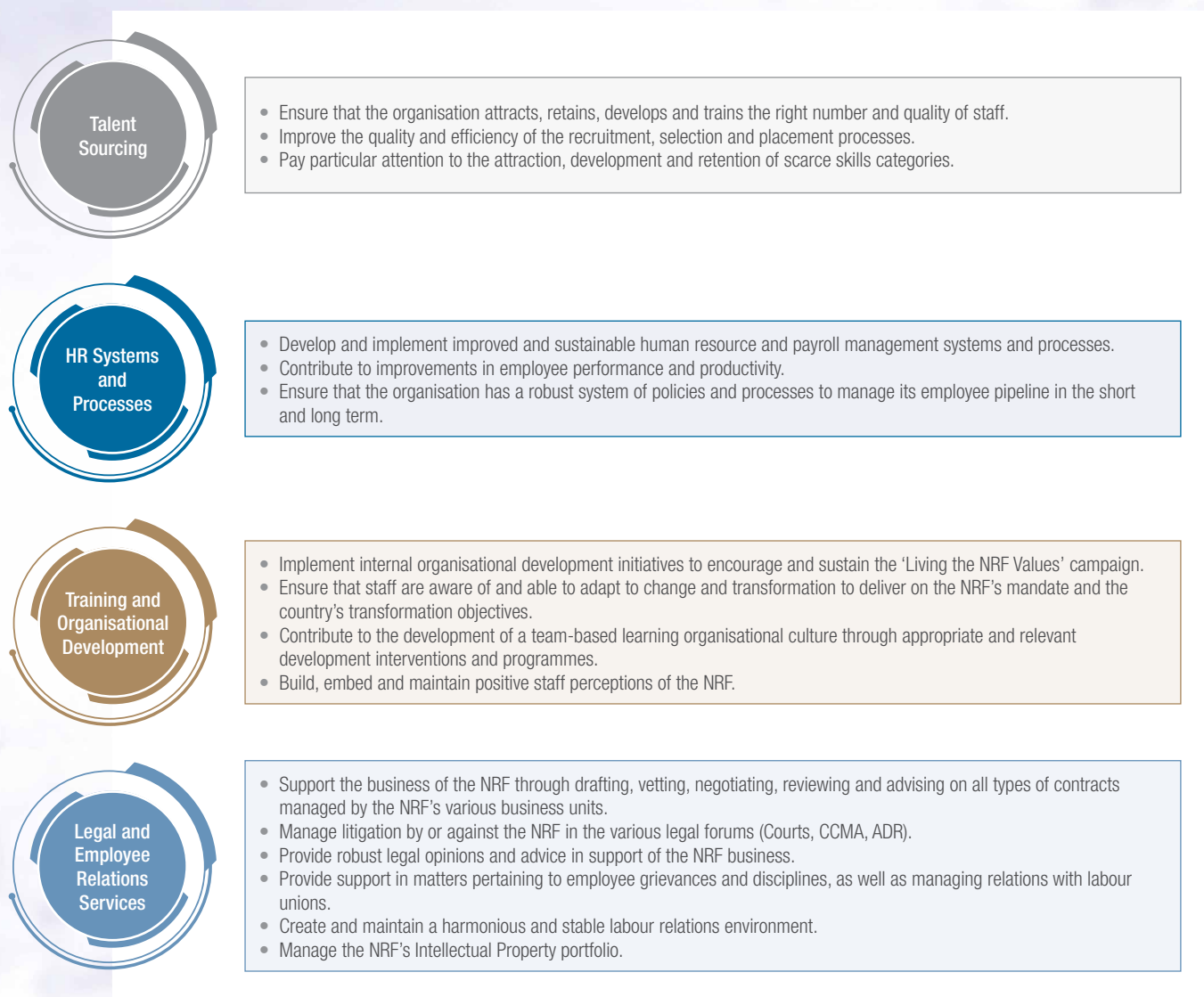
Talent management includes the successful attraction, placement, retention and continuous development of a committed and skilled staff cohort representative of the areas in which the NRF operates.

PROVIDE POLICY DIRECTION AND STRATEGY FOR EFFECTIVE HUMAN RESOURCE MANAGEMENT AND LEGAL SUPPORT SERVICES

The Human Resources and Legal Services (HR&LS) division provides policy direction and strategy execution guidelines for effective human

resource management in furtherance of the organisation’s overall transformation framework and mandate. The division leads, promotes, and coordinates organisation-wide activities to enhance organisational effectiveness, productivity, and interactions with internal and relevant external stakeholders. As a corporate function, the scope of activities cuts across all the business units of the NRF. In discharging its mandate, the division is supported and assisted by other NRF business-enabling functions, such as ICT and finance. The key HR and legal services and activities are set out on the next page:

Figure 12: Human resources and legal services activities



ALIGNMENT TO CODES, LEGISLATION, PRACTICES, AND STANDARDS

The HR&LS function complies with – and ensures adherence to – a range of legislation, codes, and standards as set out on pages 112 and 113.

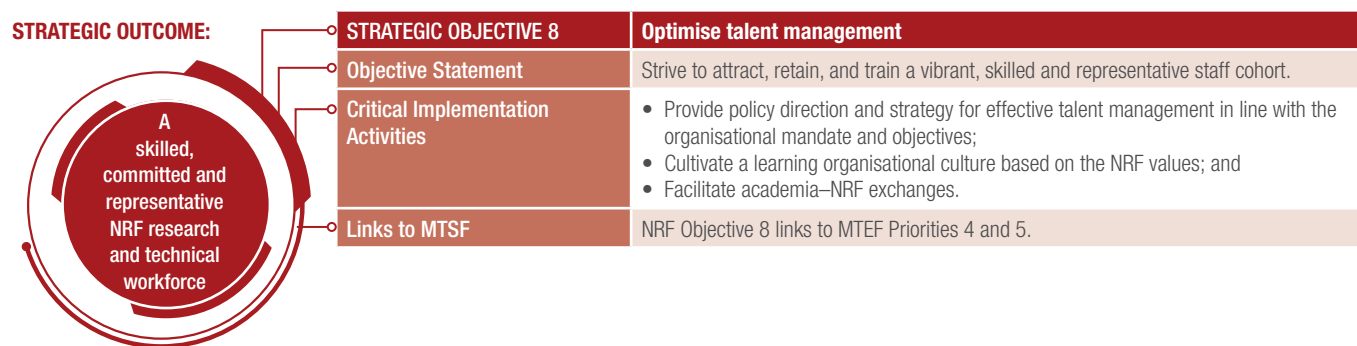
EMPLOYMENT EQUITY AND TRANSFORMATION

The NRF has a diverse workforce and is progressing steadily towards the Strategy 2020 demographic targets. These goals will be achieved through concerted recruitment efforts, effective retention of designated staff and succession planning where appropriate. Gender representation in the senior officials and technical/scientific categories, as well as racial representivity in the technical/scientific categories will receive focused attention.

The organisation may experience some challenges due to budget limitations as well as the scarcity and competition for highly specialised skills required in some areas of the NRF business. In addition, the remoteness of certain NRF sites makes it difficult to recruit and retain employees from designated groups. However, interventions will be put in place to ameliorate these challenges. The anticipated interventions include professional development and internal staff rotation to increase exposure and experience, as well as staff secondments to and from higher education and similar institutions to broaden staff skills and experience. Over the MTEF period, the unit will implement a range of strategic policy and process adjustments. These include:

- Refinement of the Performance Management framework and associated reward mechanisms to meet the organisation's performance delivery expectations;
- Stabilisation of the newly declared National Facility, the South African Radio Astronomy Observatory (SARAO) within the NRF governance and management structures;
- Rolling out of the contract management policy, and implementation of the contract management system for existing and new NRF contracts;
- Re-conceptualisation and automation of the grievance and disciplinary case management system;
- Managing intellectual property endeavours in compliance with regulatory requirements;
- Implementation of renewed Management Development (MDP) and New Managers Development Programmes (NMDP);
- Providing or facilitating customised training, developmental and support programmes;
- Implementation of innovative recruitment and selection tools;
- Continued enhancement of the organisational climate, and the creation of an agreeable work environment;
- Driving transformation through continued and focused implementation of the recommendations derived from the customised NRF Diversity Management Programme in partnership with the WITS Centre for Diversity Studies;
- Intensifying skills development and staff retention efforts to achieve the desired transformation objectives through:
 - Skills development initiatives that target technical, scientific, managerial and leadership skills at appropriate levels;
 - Absorption of skilled bursary, scholarship and internship candidates into the organisation wherever possible;
 - Improvement in the succession planning initiatives by identifying candidates and adopting focused mentorship and other training interventions and plans to increase the competency levels of these candidates; and
 - Adopting targeted recruitment initiatives to ensure fair representation of gender, race, and people with disabilities.

Table 9: Programme 1 – KPIs against budget (2018/19–2020/2021) – Strategic Objective 8



INDICATORS		Actual 2015	Actual 2016	Actual 2017	Target 2018	Proj. 2019	Proj. 2020	Proj. 2021
Proportion of South Africans from designated groups in senior technical and managerial positions (Peromnes 1–8)	Black number	250	275	287	262	265	265	265
	Black %	44%	45%	46%	45%	46%	46%	46%
	Female number	179	195	198	187	190	190	190
	Female %	31%	32%	32%	32%	33%	33%	35%
% staff turnover		8.9%	8.9%	10.5%	6.7%	6%	6%	6%
BUDGET (R million)		Actual 2015	Actual 2016	Actual 2017	Target 2018	Proj. 2019	Proj. 2020	Proj. 2021
Training and development		5,141	4,543	2,648	5,400	5,685	5,967	6,262

Note: The amendment to the ratio and number of black and female South Africans in senior technical and managerial position targets is due to the departure of the NZG.



PROGRAMME 2 – SCIENCE ENGAGEMENT

9.1 SITUATIONAL ANALYSIS

Demystifying research and research outputs for the general public is pivotal in the creation of an innovation culture. In a knowledge society the awareness of and the necessity for science and research are not only understood by society, but the full value proposition is prioritised and advocated for. From a policy perspective, the NDP also focuses extensively on the application of science and technology in the transition towards such a knowledge economy. It emphasises the effective application of science literacy as follows:

“...to promote technological advances, developing countries should invest in education for youth ... and should ensure that knowledge is shared as widely as possible across society”.

Science engagement is therefore a strategic priority and has been incorporated into the NRF Amendment Bill 2016 which proposes to legislate the importance of science engagement and establishes NRF/SAASTA as the national coordinating body for science engagement.

The Science Engagement Framework aims to integrate the natural sciences, engineering, social sciences, and humanities, in pursuit of a society that understands and values science and technology and its critical role in national prosperity and sustainable development, while engaging critically in societal development. The goals of the framework are to:

- Popularise science, engineering, technology and innovation as attractive, relevant and accessible in order to enhance scientific literacy and awaken interest in relevant careers;



- Develop a critical public that actively engages and participates in the national discourse of science and technology to the benefit of society;
- Promote science communication that will enhance science engagement in South Africa; and
- Profile South African science and science achievements domestically and internationally, demonstrating their contribution to national development and global science, thereby enhancing their public standing.

The South African Agency for Science and Technology Advancement (SAASTA), a business unit within Programme 2, is, through the NRF Amendment Bill 2016, given responsibility to improve coordination of and encourage science promotion, communication, and science engagements across the national system, including partners in other sectors of society, and will do so by:

- Establishing and running an effective and efficient grant-management system in support of collaborative science engagement;
- Designing and implementing programmes that would enhance the goals of the strategy – including the establishment of necessary partnerships with relevant institutions;
- Ensuring alignment of its programmes with government policies in general and DST priorities in particular;
- Overseeing the efficient and effective use of resources (financial and human) relevant to science engagement;
- Collecting, collating, analysing and disseminating national data on the performance of the system, going beyond the work of the DST and its entities;
- Overseeing the implementation of a science-engagement information management system together with the relevant partners; and
- Leveraging of external resources (financial, infrastructure, and human) to advance science engagement.

Over the 2018/19 financial year, and subject to available resources, SAASTA will perform the following key initiatives related to its broader coordination role:

- Ensuring that the necessary systems are in place in order to enable SAASTA to fulfil its role as a national coordinator of the science engagement framework. The programme will utilise the existing NRF IT systems, such as the grants management system, to coordinate such efforts. This must be supported by the improved planning of an annual call schedule that starts to

systematise science-engagement activities for the participating institutions. The contract funding situation will thus be addressed to allow for this longer-term planning.

- Approval of a concept document for a new funding model for science engagement coordinated through SAASTA, including human capacity recruitment and development in identified key business areas.
- Conducting a baseline study on the status of science engagement in South Africa (stakeholders, programmes, funding, and reach). This information will inform the move towards a more balanced programme mix across the sector in order to deliver on the four main objectives of the framework.
- Development of an integrated science-engagement strategy with RISA that supports science engagement contributions by NRF-funded researchers. This will require a more nuanced capturing of data that starts to address the ongoing work in developing appropriate indicators for science engagement.
- Building strategic capability with respect to programme planning, monitoring and evaluation as well as the creation of indicators in partnership with the science communication Chairs, such that science-engagement activities can be appropriately monitored and measured from a system perspective.

9.2 CONTRIBUTIONS TO STRATEGIC OBJECTIVES

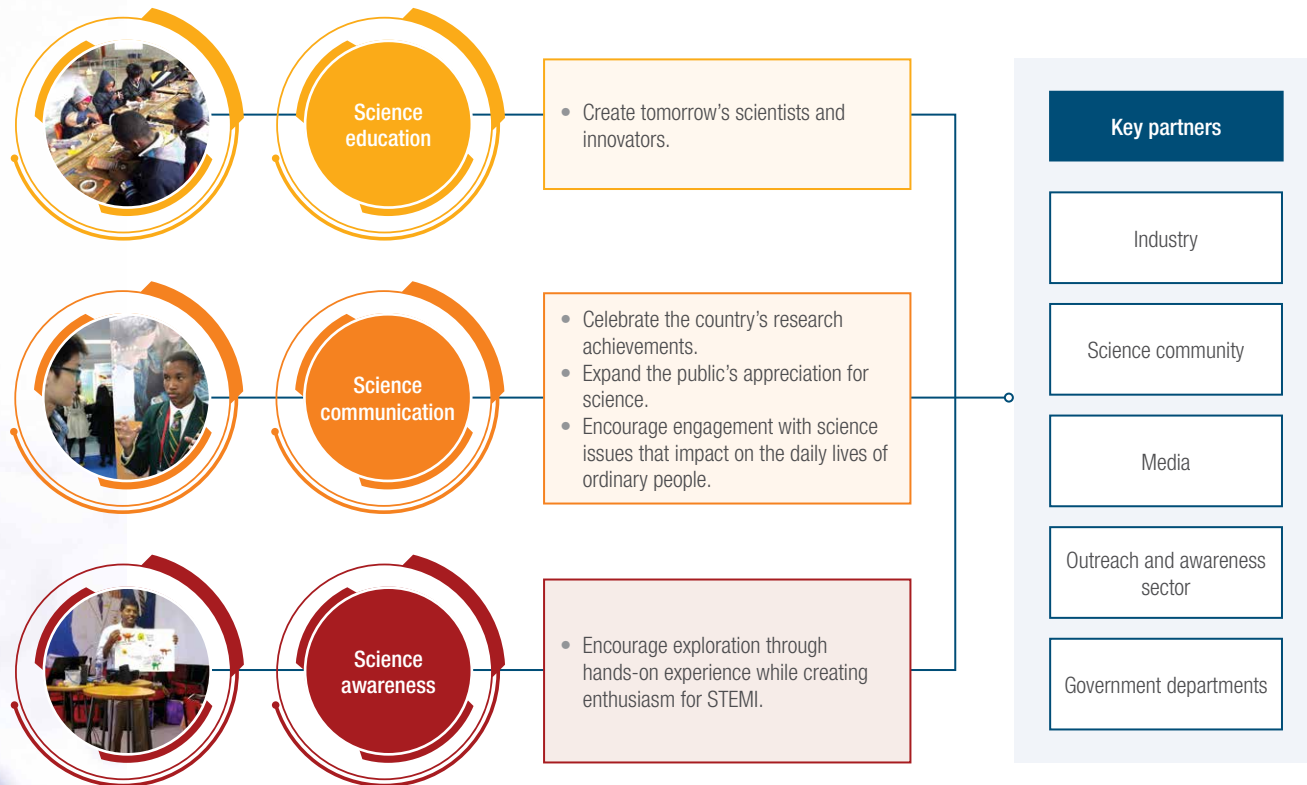
Entrenching science engagement throughout the NRF and within the broader society is one of the five key strategic goals of *NRF Strategy 2020*. The envisaged outcome of this strategic goal is to create and promote a “scientifically literate and engaged society”. To achieve this, the NRF adopted an integrated science-engagement model through which SAASTA, the science engagement units in all NRF Research Facilities and the Research and Innovation, Support, and Advancement (RISA) business divisions, are involved in science engagement.

The process of aligning science engagement across the NRF forms an integral part of its commitment to the nurturing, promotion and development of knowledge while ensuring active public participation in the process and thus promotes an interface between science and society. This public engagement with science in the NRF is driven through Programme 2 (Science Engagement) by means of a clearly articulated implementation plan to ensure delivery. Over the next few

years the NRF, through SAASTA, will work mainly towards coordinating the implementation of the Science Engagement Strategy across the NRF and other DST entities.

Within the NRF, all science-engagement activities have been consolidated under three focus areas: science education, science awareness, and science communication.

Figure 16: Science-engagement focus areas



9.2.1 STRATEGIC OBJECTIVE 7: ENTRENCH SCIENCE ENGAGEMENT

9.2.1.1 Science Education

A. Learner support

Programme 2 develops, implements, manages, and coordinates projects that improve learner participation and performance in science and technology critical areas, supplementing the curriculum through career profiling; role modelling; teaching and learning resources; Olympiads and competitions; science camps and workshops; and visits to the various science platforms. These initiatives are presented jointly and individually by SAASTA and the National Research Facilities. In addition, some Centres of Excellence (COEs) and Research Chairs (SARCHI) undertake learner and educator support programmes.

B. Educator support

The role of an educator is imperative in the nurturing of a learner's evident or latent talent. To ensure that learner performance in the critical areas of science, engineering, and technology (SET) improves, continuous educator development is vital. Programme 2 collaborates with the Department of Basic Education (through maths, science and

technology coordinators, curriculum advisers, and district managers), professional associations (including the South African Association for Science and Technology Educators and the South African Institute of Physics), and universities to innovate, conceptualise and implement content and methodology workshops and resources for educator development activities across the country through the following activities:

- National Science Olympiad™
- Natural Science Olympiad™
- AstroQuiz™
- National school debates
- National Science Lens Competitions™
- Young Science Communicators Competition™
- Famelab
- Techno Youth™
- Science camps for learners with potential
- Primary school science interventions
- Educator support in M|PS|LO – Maths and Physical Sciences
- Science expos
- Planet Earth and beyond collaborations
- “Universe in the box” materials

Table 10: Learner and educator support

	2016/17	2017/18	2018/19	2019/20	2020/2021
Number of focused STEMI interactions with learners and educators	9	10	11	11	11
Number of educators reached	15 210	2 500	2 800	3 000	3 000
Number of learners reached	374 403	215 000	220 000	225 000	225 000



9.2.1.2 Science Awareness

A. Public engagement with science

South Africa's research and innovation system is expected to assist in finding solutions to the social and economic challenges of the country. Global competitiveness, shrinking resource availability and the requirements of a skilled labour force mean that an awareness and understanding is increasingly required about why science, research, and innovation are critical in developing a knowledge society. Members of the public are generally engaged through science festivals, exhibitions, and facility tours at the National Research Facilities. Some of the facilities also offer internships and/or job-shadowing opportunities. It is imperative to ensure that public awareness initiatives extend to rural communities. More than 60% of the current initiatives involve rural communities. The activities include:

- National Science Week
- Science festivals and international days
- Sky viewing at the observatories
- World Space Week
- National Youth Service Programme
- Science Train project (Matjiesfontein)
- Programmatic support grant intervention (science centres)
- Science centre accreditation
- Science centre capacity building
- Community engagements at local National Facilities level (Sutherland and Carnarvon)

To ensure continued and increased engagement, SAASTA as national coordinator will:

- Conduct baseline studies concerning the current reach in all nine provinces, by municipality and districts within municipalities. This will enable SAASTA to identify the current gaps and develop strategies to ensure that there is increased coverage in rural areas.

- Work closely with the Media Development and Diversity Agency (MDDA), which is the custodian of over 300 community media projects (print and broadcast) across the country, to ensure that more rural communities are targeted and that science is communicated to those communities in their mother tongue. This is an existing partnership mainly in Limpopo province but which, with additional resources, can be extended to other provinces as well.
- Encourage and provide incentives to scientists and researchers to be involved in science engagement activities targeting rural areas across the country. Existing platforms, such as role-modelling campaigns can be extended, while new partnerships with local industries will be explored to advance community engagement.
- Build capacity (human and infrastructure) in those science centres that are located in or close to rural communities, and explore the increased use of mobile units and travelling exhibitions.

In addition to participation in festivals, the following exhibitions and facility tours will be undertaken:

- SARAO will partner with CSIRO to learn best practice in citizen science developed by the organisation through its Pulsar Parkes Citizen Science Programme. The partnership will include the use of the Parkes radio telescope for citizen science by science centres in South Africa, and the development of SARAO's own citizen science programme using HartRAO and/or KAT-7 and/or small-scale interferometers.
- SAAO public stargazing continues to attract large numbers of members of the public and thus SAAO will be hosting stargazing

sessions in collaboration with amateur astronomy groups in the townships.

- SAIAB offers tours and courses for compliance and conservation officers in the biodiversity sector from DEA (Oceans and Coasts), DAFF and certain SADC countries in the correct identification of the various fish resources in Africa's waters as requested.

9.2.1.3 Science Communication

Science communication is a critical component in developing an informed public that actively engages and participates in the national discourse of science and technology towards practical implementation for societal benefit. Specialist areas within science communication include media engagement, audience analysis, scientific editing, ICT specialisation, and discipline-specific science communication. Discipline-specific communication areas currently include biotechnology, nanotechnology, hydrogen fuel cell technology, space science, the palaeosciences and Antarctica. In addition, science communication in scientific disciplines such as astronomy, biodiversity, conservation and the nuclear sciences is also undertaken by the various National Research Facilities.

The NRF offers a variety of interventions to improve capacity in quality science communication. Two SARChI Chairs in Science Communication have been awarded and will provide leadership in the discipline over the MTEF.

Table 11: Public awareness

	2016/17	2017/18	2018/19	2019/20	2020/2021
Number of planned SAASTA interactions	10	11	12	13	13
Estimated number of public reached	1 040 000	1 080 000	1 080 000	1 090 000	1 090 000

A key focus in the 2018/19 financial year is the development of an integrated science engagement plan for Programme 3 (RISA) to profile and communicate the broader impacts of NRF-funded research more effectively. Researchers will be encouraged to participate in science engagement and their contributions will be factored into their annual performance reports. Science engagement is also promoted through an established Science for Society lecture series, held each year in collaboration with various universities and researchers from the CoE and SARChI programmes.

Other planned science engagement partnerships include:

- A Nobel laureate lecture series in partnership with the Embassy of Sweden.
- SAIAB has been selected as one of the Embedded Nuclei for the second phase of the EU-funded NUCLEUS project. NUCLEUS is a four-year, Horizon 2020 project bringing responsible research and innovation (RRI) to life in universities and research institutions. NUCLEUS studies responsible research and innovation in Europe, China and South Africa. NRF-SAASTA is the country partner of NUCLEUS and NRF-SAIAB has been selected as a case study for how RRI can be entrenched in a research institute. The ultimate goal is to contribute to recommendations for the implementation of RRI in universities and research institutes.
- SKA SA will initiate its Arts and Science Small Grants Programme for the research, design, development and implementation of projects that use art to engage the public in conversations about radio/astronomy and the research and science outcomes of HartRAO, MeerKAT and SKA.

In general, activities will include:

- Competitions;
- Workshops for science communication skills development in scientists and researchers;
- Promotion of science journalism;
- Partnerships with community media to promote science in indigenous languages;
- Increasing media placement of science-related material;
- Translation of scientific information into audience-specific resources (this incorporates the science editing, production and ICT functions), for example fact sheets, posters, media-friendly articles, communication products, booklets, career brochures and information videos; and
- Information dissemination on key science and technology areas.

Note: KPI targets may be adjusted depending on contracts received during the 2018/19 financial year.


The reduction of the target for number of educators reached is due to:

- The continuous decrease in contract funding from the DST and the minimal increase in core funding to SAASTA and funding of science engagement in NF. Almost all the core funding at SAASTA deals with salaries and operational costs such as municipal rates and taxes, security, cleaning and maintenance of existing ageing infrastructure and there is little left to deal with increasing educator reach.
- Decrease and non-renewals in sponsorships from the business sector (targeting educators) due to the current economic climate.
- The NZG, a crucial contributor to the KPI, was moved from the custodianship of the NRF, further contributing to the reduced targets.
- A new approach in educator development was adopted, which is more focused (conducting a number of activities/workshops with the same educators) to ensure that there is a definite impact on teaching and learning in the classrooms).

Table 12: Science communication

	2016/17	2017/18	2018/19	2019/20	2020/2021
Number of planned SAASTA development interventions	11	10	10	11	11
Number of planned SAASTA multimedia science features	1 716	800	TBC	TBC	TBC

Table 13: Programme 2 – KPIs against budget (2018/19–2020/21) – Strategic Objective 7

	STRATEGIC OBJECTIVE 7	Entrench science engagement
	Objective Statement	Science engagement with society for the promotion of a vibrant national research culture through the implementation of effective science awareness, science education and science communication activities.
	Critical Implementation Activities	<ul style="list-style-type: none"> Cultivate science awareness through education and communication, as well as implementation of effective science-engagement initiatives Implementation of science engagement in RISA Implementation of science engagement in Programmes 4 and 5
	Links to MTSF	NRF Objective 7 links to MTSF Priorities 1 and 14.

INDICATORS		Actual 2015	Actual 2016	Actual 2017	Target 2018	Proj. 2019	Proj. 2020	Proj. 2021
Investments in science-engagement activities (SAASTA & NFs) (R million)		73,92	100,78	106,1	86,26	139,552	133,263	138,731
Interactions with the public (learners, educators and general public) (SAASTA)	Number of interactions	10	7	10	12	13	13	13
	Approximate number of members of the public reached	972 547	1 013 716	1 084 000	1 080 000	1 090 000	1 090 000	1 090 000
Interactions focusing on educator development and learner performance in mathematics, technology and science	Number of interactions	11	12	17	11	12	12	12
	Educators reached	18 578	19 410	17 997	2 800	3 000	3 000	3000
	Learners reached	318 824	371 624	374 457	220 000	225 000	225 000	225 000
BUDGET (R million)		Actual 2015	Actual 2016	Actual 2017	Target 2018	Proj. 2019	Proj. 2020	Proj. 2021
Science Engagement		153,745	179,362	174,826	126,144	139,552	133,263	138,731

10 PROGRAMME 3 – RISA

10.1 SITUATIONAL ANALYSIS

Programme 3, Research and Innovation Support and Advancement (RISA), executes the granting function of the NRF. The division supports and promotes research through the development of human capacity, the generation of knowledge, and the provision of and access to cutting-edge research infrastructure. Structuring of the programme is flexible and responsive to adapt seamlessly to the varying needs of the NSI.

The business of Programme 3 is informed by a range of national policies, strategies and priorities of government, including the strategy for human capacity development (HCD) for research, innovation, and scholarships and the 2013 Ministerial Guidelines for Improving Equity in the Distribution of DST/NRF Bursaries and Fellowships. RISA contributes to a sustainable and globally relevant NSI by:

- Promoting international competitive research as the basis for a knowledge economy;
- Providing cutting-edge research, technology and innovation platforms; and
- Operating a world-class granting, review and evaluation system.

The NRF will continue to align its funding investment to national research priorities. RISA executes its grantmaking function through the following operational structure:

- **Human and Infrastructure Capacity Development (HICD)** focuses on developing individual research capabilities through support for next-generation and emerging researchers and institutional research capabilities through the provision and access to research infrastructure.



- **Knowledge Advancement and Support (KAS)** facilitates, promotes, advances and supports knowledge production and application through funding and other interventions, and in the process support the development of related human capacity.
- **Research Chairs and Centres of Excellence (RCCE)** manages two strategic funding instruments, namely the South African Research Chairs Initiative (SARChI) and the Centres of Excellence (CoE).

These directorates are supported by:

- **RISA Finance and Administration** provides the full financial and administrative support functions for the RISA business division of the NRF, as well as to the NRF Corporate Office.
- **Grants Management and Systems Administration (GMSA)** performs and coordinates all grants management activities and manages funding processes.
- **Reviews and Evaluations** facilitates peer evaluations and reviews in support of granting decisions.

TRANSFORMATION OF THE SCIENCE AND TECHNOLOGY LANDSCAPE

A core tenet of *NRF Strategy 2020* is transformation by promoting the diversification of the research cohort, with particular emphasis on persons from designated groups, thereby transforming the research workforce. The NRF will, through a variety of interventions, catalyse the transformation of the science and technology system. These include, *inter alia*, targeted grant-funding instruments that focus on women and black researchers, and the fast-tracking of black female doctoral graduates in obtaining their NRF rating.

Through RISA, the organisation will continue to focus on and implement targeted funding instruments in support of students, emerging researchers and established researchers. A particular focus will continue to be placed on developing a sustainable long-term participation of persons from the designated groups in the HCD pipeline, in particular the emerging researchers, such as:

- The expanded **Thuthuka Funding Framework** focused on support for doctoral and postdoctoral research. This instrument supports the development of emerging researchers holding academic positions at universities or research positions at public research institutions, thus enabling the transition to the established researcher cohort as evidenced through the NRF ratings;
- The **Professional Development Programme (PDP)** for the placement of doctoral students and postdoctoral researchers at the National Research Facilities, science councils and other public research institutions;
- The expanded NRF **postdoctoral placement** programmes;
- The **Sabbatical Grants** which enable academic staff from designated groups to complete their doctoral degrees. The new partnership between the First Rand Foundation (FRF) and the NRF will focus on South African and African emerging researchers and persons with disabilities; and
- Providing funding to NRF **Y-rated researchers**, especially those from the designated groups, to ensure that they develop into stronger, established researchers.

In addition, the NRF will continue to ensure that there is continuous transformation of the NRF Specialist Rating Committees and reviewers by actively identifying and appointing excellent researchers from designated groups. Customised interventions for those institutions that require research and researcher development through targeted capacity-building initiatives will be undertaken. The focus will be on HDIs and rural based universities and universities of technology. Bespoke institutional interventions will be implemented to increase the number of black and women rated researchers, via a partnership model with the NRF.

RESEARCH FOR SOCIETAL BENEFIT

Research and innovation has the potential to impact positively on quality of life. The NRF ethos of supporting “excellence with relevance” is central to the achievement of the organisational mandate. Through strategic investments in SARChI, the CoEs, and the National Research Facilities, the NRF creates multidisciplinary research platforms that support the exploration of innovative research in areas of national significance. In order to track its performance appropriately, the NRF pays special attention to the number of graduates, and the number and quality of scholarly publications as an output of NRF funding.

Assessment of the real socio-economic benefit of these investments in research is an emerging priority for the NSI. The NRF therefore commissioned a study titled *Exploratory evaluation of the socioeconomic impacts of selected NRF funding instruments*. This has provided baseline data and methodology for future analysis, which will be used to better inform the NRF investments for greater societal impact. Over the MTEF period, the NRF will introduce various impact assessment methodologies and processes to ensure that the organisation is able to track, measure and report on the long-term impact of its investments.

10.2 CONTRIBUTIONS TO STRATEGIC OBJECTIVES

10.2.1 STRATEGIC OBJECTIVE 1: PROMOTE GLOBALLY COMPETITIVE RESEARCH AND INNOVATION

The NRF provides support across the full spectrum of current and future knowledge workers' careers. This is achieved through a human capacity development pipeline as illustrated in Figure 15, which informs the support for next-generation researchers from honours to doctoral level, emerging researchers from postdoctoral level, and established researchers. In facilitating and supporting research and human capacity development, the NRF uses a range of instruments such as the Thuthuka programme, the CoEs, and SARCHI that offer focused, multidisciplinary and transdisciplinary research environments that support innovative, solutions-orientated research in societally relevant fields.

Funding is provided through a variety of dynamic strategic instruments which cover different modalities, focus areas, subject areas, priority areas, values, geographical areas, designated groups, strategic choices, and other relevant considerations.

The categories can be defined as:

- Next generation – postgraduate students (Honours, Masters, Doctoral).
- Emerging researchers – early career researchers including post-doctoral fellows, active researchers without doctoral degrees and individuals who have yet to establish themselves.
- Established researchers – individuals who have an established track record of undertaking independent research.
- Cross-cutting instruments – other funding opportunities for both postgraduate students and researchers.
- Strategic investments – SARCHI Research Chairs and Centres of Excellence.
- National equipment programme – discussed under 10.2.4.

Figure 14: Investment in postgraduate students and researchers

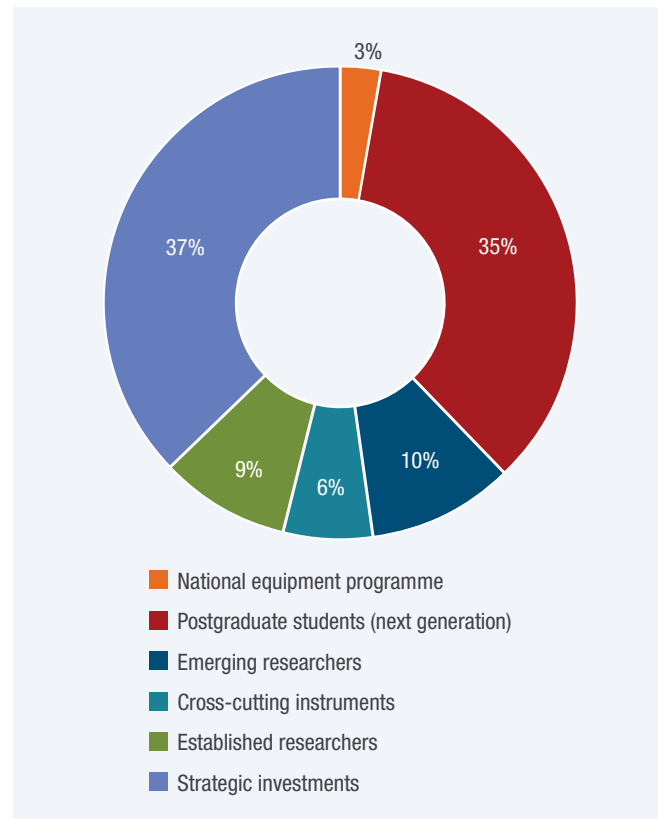


Figure 15: Human capacity development investment trend 2016/17 - 2020/21

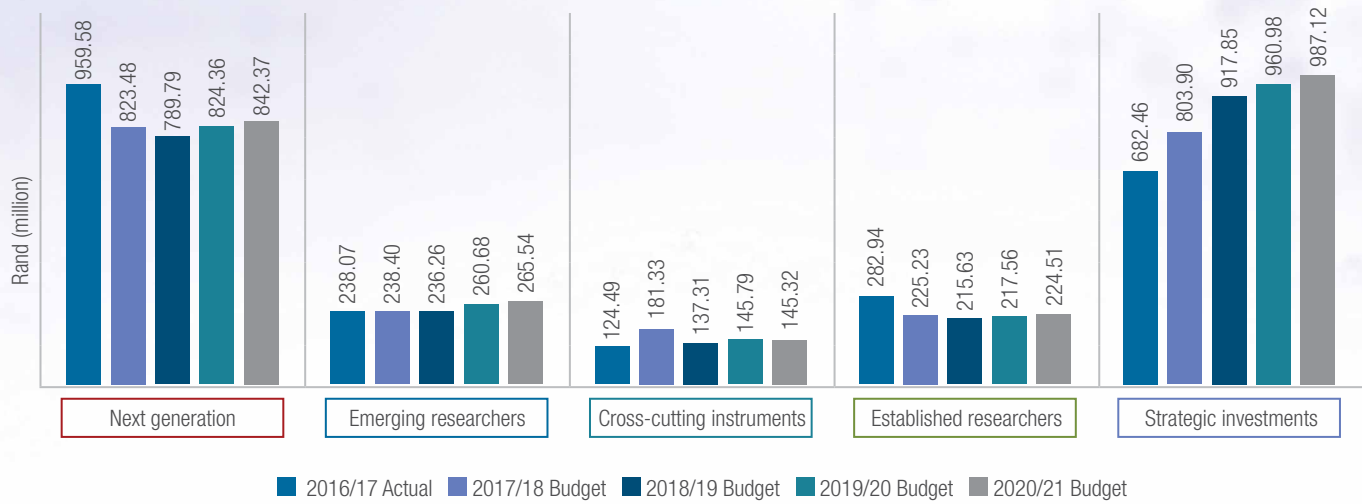
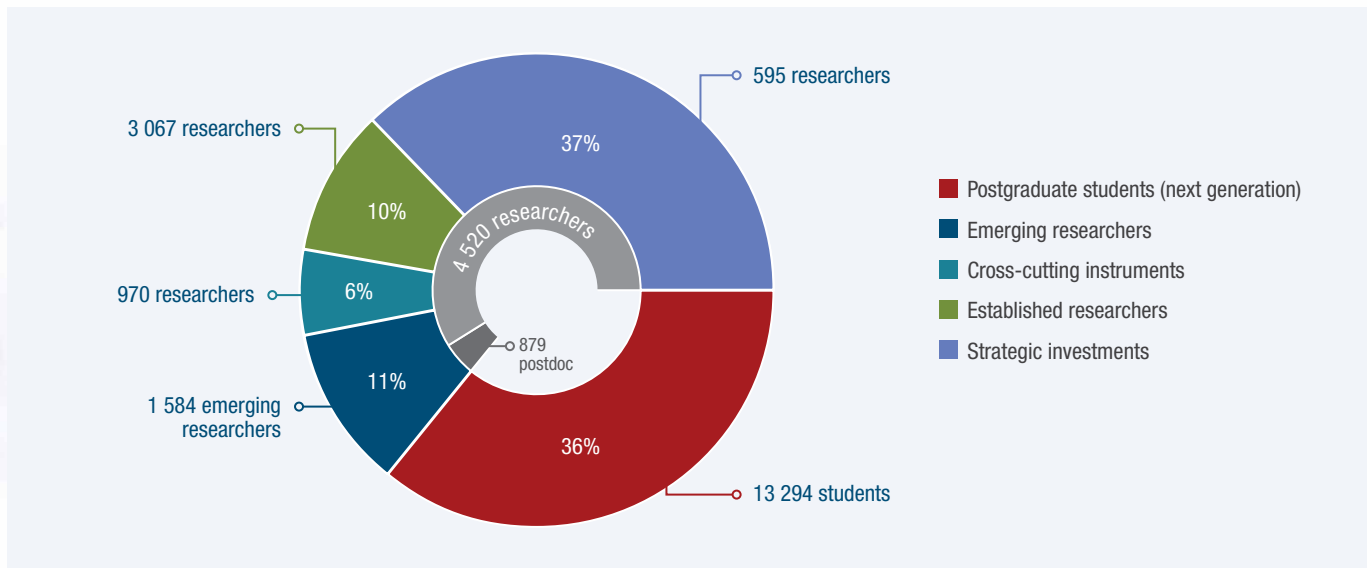


Figure 16: MTEF commitments towards human capacity development



A. DST-NRF Internship Programme

This programme supported 4 904 interns over the last five years. In line with the DST TYIP the scope of the programme was expanded to include graduates in the humanities and social sciences. The NRF will place another 1 851 interns over the MTEF period.

B. Student support

The NRF invests in developing the next generation of researchers through the competitive awarding of free-standing scholarships, grantholder-linked bursaries and academic development programmes to honours, masters and doctoral students. On average, the NRF invests 36% of the total HCD investment in this area. This amounts to R790 million in the 2018/19 financial year, with a total investment of R2.46 billion over the MTEF period. This represents an average increase of 6% in nominal terms, but a slight decrease of -2% in real terms. This decrease in real terms is further exacerbated by the low values of the NRF bursaries relative to the real cost of postgraduate education and cost of living. The targeted investment strategy for next-generation researchers has, however, resulted in a steady increase in the number of black and female students being supported.

Based on projected income over the five-year strategy period, the NRF aimed to support 5 600 master's and 3 300 doctoral students during the 2018/19 financial year. Given the less than favourable growth in income, as well as a reduction in the DHET National Scarce Skills Fund, the NRF expects to be able to support 4 582 master's and 3 066 doctoral students. On aggregate, it is expected that 77% of all postgraduate students will be black and 58% will be female. By the year 2021, the NRF expects that 80% of the next-generation cohort will be black and 57% will be female.

The NRF has partnered with the National Student Financial Aid Scheme (NSFAS) to collaborate and cooperate on initiatives that will bring about increased access to funding opportunities to postgraduate students; to identify financially needy postgraduate students; and to





manage National Skills Fund funding for honours and final year B Tech students who received NSFAS funding for their undergraduate studies. Through this agreement between the NSFAS and the NRF, the NSF allocation of R75m for Honours and B Tech students was allocated to the NRF instead of the NSFAS in 2017/18. While this has offset the reduction in the allocation to the NRF, the net effect for the system is a reduction in the total number of bursaries funded by the NSF.

In addition to the bursaries and scholarships, the NRF provides grantholder-linked bursaries and fellowships that ensures that researchers funded by the NRF provide supervisory and mentoring support to next-generation researchers in their field of research. To accelerate the development of the identified vulnerable disciplines such as nursing, mathematics and statistical sciences, support will continue for a cohort of over 35 nursing doctoral students; and special funding support for the development and functioning of various interventions such as the Graduate Academy for Mathematics and Statistical Sciences will be made available.

C. Emerging researchers

Emerging researchers consist largely of postdoctoral fellows. Other early career researchers that occupy research or academic positions but have not as yet obtained a research doctorate are also included in this category. The NRF sees this cohort as the additional supervisory capacity and established researchers of tomorrow and, for this reason, ensures that emerging researchers benefit from a range of targeted funding instruments. Even though the NRF is expecting a nominal annual increase in investment in this cohort over the MTEF period, this increase will translate into a net decrease in real terms. This investment will not meet the demands of the large emerging researcher cohort and in fact cannot sustain the desired growth rates in support of this cohort, as had been projected from the previous MTEF planning cycle. This situation will constrain the NRF's ability to provide targeted support for black and female research and instructional staff with doctoral degrees, towards becoming established researchers.



Specific initiatives over the MTEF period will include:

- The **Collaborative Postgraduate Training Initiative**, which is a funding instrument aimed at supporting postdoctoral human capacity programmes in strategic areas as set out in the South African Human Resource Development Strategy (2012–2030). This funding instrument is designed to make provision for critical areas, with preference given to partnerships that include rural-based and historically disadvantaged institutions.
- The **Thuthuka Initiative** supports both next-generation researchers and emerging researchers from historically disadvantaged backgrounds. Investment has been devoted to postgraduate training, doctoral and rating fast-track as well as competitive funds for emerging researchers.
- The **Researcher Mentoring Initiative** has been established to accelerate the development of black and especially female researchers. This includes assisting black women with doctoral qualifications to obtain an NRF rating. Each of these candidates will be matched with an established mentor who is an existing NRF-rated researcher in their respective field.
- The **NRF-FRF Black Academics Programme** aims to increase the proportion of suitably qualified black academic staff and academic staff with disabilities, at South African public universities.
- **Research Career Advancement Fellowships** is meant to enable emerging researchers to transition from postdoctoral fellows to independent researchers. An NRF agreement with the European Research Council (ERC) has guaranteed funding for the placement of these fellows at ERC PLs for six months to a year. A total of 68 fellows are currently supported. New entrants into this programme have not been possible due to limited resources.
- **Targeted Postdoctoral Programmes** are offered to develop emerging researchers post achievement of their doctoral qualifications.
- **New Generation Academics Programme (nGAP)** is a collaborative initiative between the DST, NRF and DHET to recruit new academics against carefully designed and balanced

equity considerations. The initiative is geared towards providing holistic and complementary support for career development of emerging researchers by focusing on teaching, learning, research and postgraduate supervision. The nGap scholars (researchers) may apply for competitive funding such as the Thuthuka grant for emerging researchers. Candidates in the doctoral or postdoctoral track are supported with a Research Development grant from the NRF for the first two years to facilitate their research or research proposal development.

- The **Professional Development Programme (PDP)** aims to accelerate the development of research professionals in key research areas through creating three-year research positions for doctoral candidates and postdoctoral researchers. The programme focuses on young researchers conducting research at science councils, national facilities and other public research institutions. It is tailored to accelerate the development of scientists and researchers who are poised to contribute to South Africa's innovation platforms.



D. Established researchers

The investment in established researchers is essential for enhancing research productivity as well as training and mentoring of the next generation of researchers. The investment must respond to the need for training and mentoring of postgraduate and postdoctoral candidates to meet the NDP targets as well as the NRF's research productivity target of 1% of the global research output. Lastly, the investment must make allowance for the growth in the number of established researchers that will progress from the emerging-researcher category.

Over the MTEF period, the investment in this area will be R571 million. A series of funding instruments that provide for self-initiated, discipline-based and/or bottom-up research projects are made available through RISA. Primary among these are the Competitive Programme for Rated Researchers (CPRR) and the Competitive Support for Unrated Researchers (CSUR). CPRR and CSUR are discipline-based funding instruments that support basic research as a foundation of knowledge production in all disciplines, including the humanities and the social, natural and physical sciences, through which approximately 3 300 researchers will be supported.

The specialised Community Engagement dedicated to the field of knowledge production through community engagement, awarded every second year, will fund up to 15 new projects. Further research support in specific fields and/or disciplines such as indigenous knowledge systems; earth systems science; human and social dynamics; marine and coastal research; and the Antarctic and southern oceans research will be continued through existing contract-funded instruments. On average, 10 to 20 researchers will be funded in each of these areas. The value of the grants relative to the cost of undertaking research remains a challenge.

Other instruments include national/local, and collaborative international and Africa collaborative grants to support knowledge production and mobility for knowledge exchange. The funding instruments for supporting research are sourced through core parliamentary contracts and international collaboration.



E. Strategic investments

SARChI aims to increase the scientific research and innovation capacity of the NSI by attracting and retaining established researchers that are considered global experts at local HEIs, science councils and National Research Facilities respectively. The initiative attempts to build a critical mass of supervisory capacity, equipment, researchers and students around the research chair in support of domain-specific research where the domains are selected with consideration given to socio-economic needs as well as global research trends.

To date, the NRF has awarded 210 chairs, of which 200 are currently operational. A total of 78% of the chairs are held by local researchers, of whom 39% are female and 26% are black. Over the MTEF period, a further R1,66 billion will be invested in SARChI. This represents a nominal increase of 10% and an increase of 4% in real terms. SARChI provides the opportunity for established researchers to collaborate in order to address identified problems. Nine SARChI chairs in the areas of poverty and inequality research developed and presented a joint funding proposal for Strategies to Overcome Poverty and Inequality under the Community of Practice (CoP) initiative. The role of the CoP initiative is to provide leadership in constituting and driving a series of research programmes, workshops and other engagements over the next year on the key themes identified. Ten other CoPs will be established over the MTEF period. The NRF is exploring, with its strategic partners, the potential to create a co-funded model for the chairs such as the SA-UK-Africa as well as the SA-Canada-Africa trilateral chairs.

Centres of Excellence (CoEs) are physical or virtual research entities that concentrate existing capacity and resources to enable researchers to collaborate across disciplines and institutions. These centres support collaboration on long-term projects that are locally relevant and internationally competitive in order to enhance the pursuit of research excellence and capacity development.

To date, the NRF has awarded 14 CoEs as shown on page 61. The National Institute for Theoretical Physics (NiTHEP) is managed as, but is not designated a CoE. Over the MTEF period, an investment of R633 million will be made in this area. This represents a nominal decrease of 2% and an actual decrease of 7% in real terms.

Collaboration with the Water Research Commission (WRC) and the Department of Human Settlements (DoHS) is being explored with the aim of setting up co-funded CoEs. This modality is being extended to the NRF's international partners, especially those on the African continent.



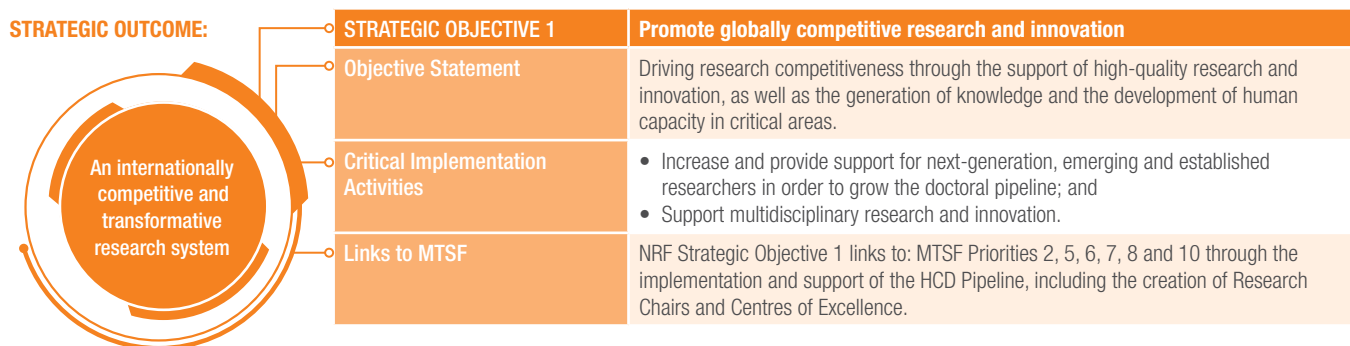
Classification of CoEs by Grand Challenges are:



In order to facilitate the advancement of existing knowledge and develop new fields of knowledge, RISA will continuously survey the research landscape within the NSI, perform an analysis of existing research areas, track and analyse research trends globally and review the needs within the NSI. Most of the knowledge-generating funding instruments within the NRF serve a dual function: to generate new knowledge and/or grow the existing knowledge base; and to train and develop the next generation of researchers.

For explanations of acronyms, please refer to the list of acronyms on page 115.

Table 14: Programme 3 – KPIs against budget (2018/19-2020/21) – Strategic Objective 1



INDICATORS		Actual 2015	Actual 2016	Actual 2017	Target 2018	Proj. 2019	Proj. 2020	Proj. 2021
Number of NRF-funded researchers from designated groups	Black	1 235	1 355	1 563	1 960	2 182	2 090	2 257
	Female	1 514	1 610	1 699	2 450	1 520	2 158	2 324
Number of postgraduate students funded per designated group	Black	7 057	8 980	10 747	10 350	9 350	9 566	9 785
	Female	5 976	7 032	8 017	8 700	7 119	7 339	7 511
Number of NRF-rated researchers from designated groups	Black	765	866	970	936	1 026	1 120	1 176
	Female	962	1 054	1 176	1 188	1 292	1 400	1 470
Number of postgraduate students funded per level	Master's	4 329	4 853	4 995	5 350	4 582	4 747	4 957
	Doctoral	2 917	3 181	3 363	3 230	3 066	3 136	3 275
BUDGET (R million)		Actual 2015	Actual 2016	Actual 2017	Target 2018	Proj. 2019	Proj. 2020	Proj. 2021
Globally Competitive Research		1,567	2,253	2,269	2,168	2,347	2,472	2,557

10.2.2 STRATEGIC OBJECTIVE 2: ENHANCE STRATEGIC INTERNATIONAL ENGAGEMENTS

Through the partnership strategy managed by the SPP division in Programme 1, system-wide international engagement and access to local and international research platforms are facilitated and negotiated. RISA will implement a range of global agreements through various funding initiatives such as:

- The Newton Fund – A five-year initiative aimed at developing science and innovation partnerships between South Africa and the UK, in which more than 600 grants and fellowships will be awarded;
- ERAfrica – An initiative aimed at promoting a unified European approach to collaborating with Africa in the fields of science and technology research for innovation and sustainable development

(up to 17 African and European countries will collaborate under a common granting initiative, with a €10 million ERANet grant from the EU in support of the approach); and

- The establishment of SA–Canada–Africa trilateral chairs – the initiative seeks to invest in the development of research in sub-Saharan Africa through the establishment of trilateral partnerships involving researchers from Canada, South Africa and a sub-Saharan African country.

The Knowledge Interchange Collaboration (KIC) funding instrument is South Africa’s largest mobility programme, supporting South Africa-based researchers in increasing and promoting their global competitiveness and innovation.

Table 15: Programme 3 – KPIs against budget (2018/19-2020/21) – Strategic Objective 2

<p>STRATEGIC OUTCOME:</p> <p>An internationally competitive and transformative research system</p>	STRATEGIC OBJECTIVE 2	Enhance strategic international engagements
	Objective Statement	Promote system-wide international engagement and collaboration in order to support emerging knowledge fields and provide local researchers with access to an innovative research infrastructure.
	Critical Implementation Activities	<ul style="list-style-type: none"> • Promote system-wide international engagement; and • Facilitate international research platform access.
	Links to MTSF	NRF Strategic Objective 2 links to: <ul style="list-style-type: none"> • MTSF Priorities 10 and 11

INDICATORS	Actual 2015	Actual 2016	Actual 2017	Target 2018	Proj. 2019	Proj. 2020	Proj. 2021
Number of active grants emanating from binational, multinational as well as agency-to-agency agreements	1 055	1 161	1 008	1 404	990	990	990
BUDGET (R million)	Actual 2015	Actual 2016	Actual 2017	Target 2018	Proj. 2019	Proj. 2020	Proj. 2021
Internationalisation	141,939	170,791	194,975	222,825	184,832	191,781	195,089

10.2.3 STRATEGIC OBJECTIVE 3: PROVIDE BEST-PRACTICE SYSTEMS IN SUPPORT OF GRANTING, REVIEWS AND EVALUATIONS

In order to contribute successfully to Strategic Objective 3, RISA pursues effective and efficient granting, evaluation and rating systems through:

- A system of planning, evaluations and reviews in support of researcher ratings, institutional and programme reviews, and the assessment of funding proposals; and
- An effective and efficient granting system.

PLANNING, EVALUATIONS, AND REVIEWS

The Reviews and Evaluation directorate is a custodian of the planning process, evaluations and reviews and will:

- Coordinate tracking and reporting on the implementation of NRF management initiatives in response to the findings and recommendations of the 2015 five-year evaluation of the NRF;
- Manage peer evaluators/reviewers with due consideration of: good training and preparation; early planning; appropriate matching; demographics balance; avoiding fatigue; and optimising support;
- Coordinate peer review evaluations;
- Coordinate cyclical evaluations of funding instruments; and
- Streamline all processes through the use of fit-for-purpose IT platforms.

AN EFFECTIVE AND EFFICIENT GRANTING SYSTEM

RISA leverages economies of scale, improves efficiencies, and adopts effective, efficient and auditable business processes to support and enhance:

- The grant management processes providing efficient and seamless quality of service and reduced turnaround times;

- Clustering and reducing similar funding instruments to reduce the number of calls made for funding and annual progress reports;
- The engagement with key stakeholders (the HEIs) in order to actively drive the process of institutions drawing down on their grants in an efficient and timely manner; and
- The support of the Business Intelligence Unit as the custodians of key business systems in the NRF. The support will include the development of an online call provisioning platform to reduce turnaround times on calls and continuous business process and IT-related engagement to improve efficiencies and reduce administrative burdens without compromising the integrity of the process.

The NRF is tasked by the DST to develop an alumni-tracking system, which will enable the organisation to track the careers of funded students and determine the long-term impact of the investment.



Table 16: Programme 3 – KPIs against budget (2018/19-2020/21) – Strategic Objective 3

<p>STRATEGIC OUTCOME:</p> <p>World-class benchmarking and granting systems</p>	STRATEGIC OBJECTIVE 3	Provide best-practice systems in support of granting, reviews and evaluations
	Objective Statement	The support of research and innovation through the provision of world-class granting, rating and evaluation systems while striving to double the investment in research to R8 billion over the next five years.
	Critical Implementation Activities	<ul style="list-style-type: none"> Pursue best-practice granting, evaluation and rating systems.
	Links to MTSF	<p>NRF Strategic Objective 7 links indirectly to:</p> <ul style="list-style-type: none"> MTSF Priorities 2, 5, 6, 7, 8 and 10.

INDICATORS	Actual 2015	Actual 2016	Actual 2017	Target 2018	Proj. 2019	Proj. 2020	Proj. 2021
Total number of researchers rated through the NRF system	3 161	3 369	3 663	3 600	3 750	3 900	4 000
BUDGET (R million)	Actual 2015	Actual 2016	Actual 2017	Target 2018	Proj. 2019	Proj. 2020	Proj. 2021
RISA Support Systems	51,496	58,447	61,908	60,916	65,017	68,533	71,014

10.2.4 STRATEGIC OBJECTIVE 4: LEADING-EDGE RESEARCH AND INFRASTRUCTURE PLATFORMS

South Africa's mission to create wealth through the creation of jobs and the eradication of poverty hinges largely on the nation's ability to develop new products, technologies, and services through research and innovation. This can only be achieved in a highly competitive world if the nation has at its disposal the required human capital capable of generating new knowledge and technologies through research in an environment with quality research infrastructure.

Appropriate and relevant research infrastructure is a necessary requirement in conducting research, the training of postgraduate students, and the efficient and effective operations of the organisation. World-class research equipment can also constitute large or specialised pieces of equipment that are needed to catapult research and student training to new levels of achievement.

ACCESS TO GLOBAL RESEARCH INFRASTRUCTURE

The NRF brokers agreements to access global research infrastructure that enable the collaboration and knowledge generation of local and global researchers. Over the MTEF period, the NRF, through Programmes 3 and 4, will continue to support the provision of and access to research and development infrastructure across the NSI, as well as support access to global research infrastructure such as:

- The European Synchrotron Radiation Facility (ESRF);
- The European Centre for Nuclear Research (CERN) – including the Large Hadron Collider (LHC); and
- The Joint Institute for Nuclear Research (JINR).

SCIENTIFIC EQUIPMENT

State-of-the-art research infrastructure, linked to the development of highly skilled knowledge workers, is a prerequisite for the generation of globally competitive new knowledge, technologies, and innovation for the twenty-first century.

A. National Equipment Programme (NEP)

The NEP, through a competitive process, makes funds available for the acquisition, upgrade or development of state-of-the-art research equipment to South African public research institutions. This investment is a critical enabler to undertaking internationally competitive research in South Africa. Due to a zero line budget on the 2017/18 MTEF, no new awards will be made in 2018.

B. Strategic Research Equipment Programme (SREP)

The Strategic Research Equipment funding instrument was introduced in the 2016/17 financial year. The SREP supports the acquisition or development of equipment that advances the frontiers of science, and addresses the development of scarce skills; attracts industry investment and involvement; and drives scientific and technological productivity and research in national priority areas. The SREP is intended to complement NEP and SARIR in providing appropriate levels of research equipment and infrastructure.

Up to 10% of the annual NEP budget will be allocated for this new competitive grant, in support of one project at a minimum of R15 million and up to a maximum of R35 million over a three-year funding period. The demand for renewal and acquisition of research equipment and infrastructure significantly exceeds these available resources.


Over the MTEF the NRF will invest around R558,1 million in the provisioning of cutting-edge research equipment and access to international research infrastructure platforms, a R260 million reduction from the planned MTEF investment. As a result of this significant change in the allocation, no new calls for equipment grants under either NEP or SREP will have been made in the 2017/18 financial year for award in 2018/19. Commitments already made for C-HRTEM, the national equipment database, and museum support will be affected.

The impact on the research enterprise will also be substantial. Currently, the NRF is only able to service 41% of the demand for equipment support. With the reduced allocation this gap will increase. The situation is further exacerbated by inflation and the volatility of the ZAR exchange rate. Consequently, KPI targets for the MTEF period have been reduced in relation to the amended allocation (Table 5).

The target for the number of users of equipment was reduced by 300 and 400 for the 2018/19 and 2019/20 financial years respectively as no new equipment grants are awarded for the 2018/19 financial year. The target for the number of publications from the use of equipment was also reduced by 300 and 600 for the 2018/19 and 2019/20 financial years, respectively.

Table 17: Programme 3 – KPIs against budget (2018/19–2020/21) – Strategic Objective 4

INDICATORS	Actual 2015	Actual 2016	Actual 2017	Target 2018	Proj. 2019	Proj. 2020	Proj. 2021
Number of users of equipment that was funded by the NEP and NNEP programmes	1 700	2 360	2 950	2 000	2 641	2 242	1 824
Number of publications emanating from the use of equipment funded by the NEP and NNEP programmes	1 700	1 105	779	1 250	695	540	430
BUDGET (R million)	Actual 2015	Actual 2016	Actual 2017	Target 2018	Proj. 2019	Proj. 2020	Proj. 2021
Platform and infrastructure provision	259,093	251,516	345,366	312,618	77,875	221,198	71,349

STRATEGIC OUTCOME:	STRATEGIC OBJECTIVE 4	Establish and maintain research infrastructure and platforms
	Objective Statement	Provide and facilitate access to world-class equipment and infrastructure through the acquisition of high-end equipment and the support of National Research Facilities.
	Critical Implementation Activities	<ul style="list-style-type: none"> • Provide science infrastructure in priority areas; and • Strategically locate research platforms.
	Links to MTSF	NRF Strategic Objective 4 links to: <ul style="list-style-type: none"> • MTSF Priorities 2 and 10, since the provision of research equipment and platforms supports research across all areas of the HCD Excellence Pipeline.



PROGRAMME 4 – NATIONAL RESEARCH INFRASTRUCTURE PLATFORMS

11.1 SITUATIONAL ANALYSIS

Providing access to adequate and relevant research infrastructure (RI) is a key enabler of globally competitive research, development, and innovation. Programme 4 supports the optimisation of synergies, collaborations and shared services, where appropriate, across the various research infrastructure platforms. National Research Facilities are mandated to provide infrastructure that is unique, requires highly qualified technicians and is beyond the capacity (financial and/or technical) of an individual university or non-governmental organisation (NGO).

Research infrastructure investment in the National Research Facilities was reduced from R235 million to R200 million over the MTEF period. The reduction in funding severely impacts the operational sustainability of the research platforms. Given the need for equipment and the long lead times for the acquisition of such equipment, the reduced investment will necessitate a review of commitments and plans made in prior years, including the cancellation of some initiatives.

11.1.1 RESEARCH INFRASTRUCTURE PLATFORMS IN THE CONTEXT OF THE SOUTH AFRICAN RESEARCH INFRASTRUCTURE ROADMAP (SARIR)

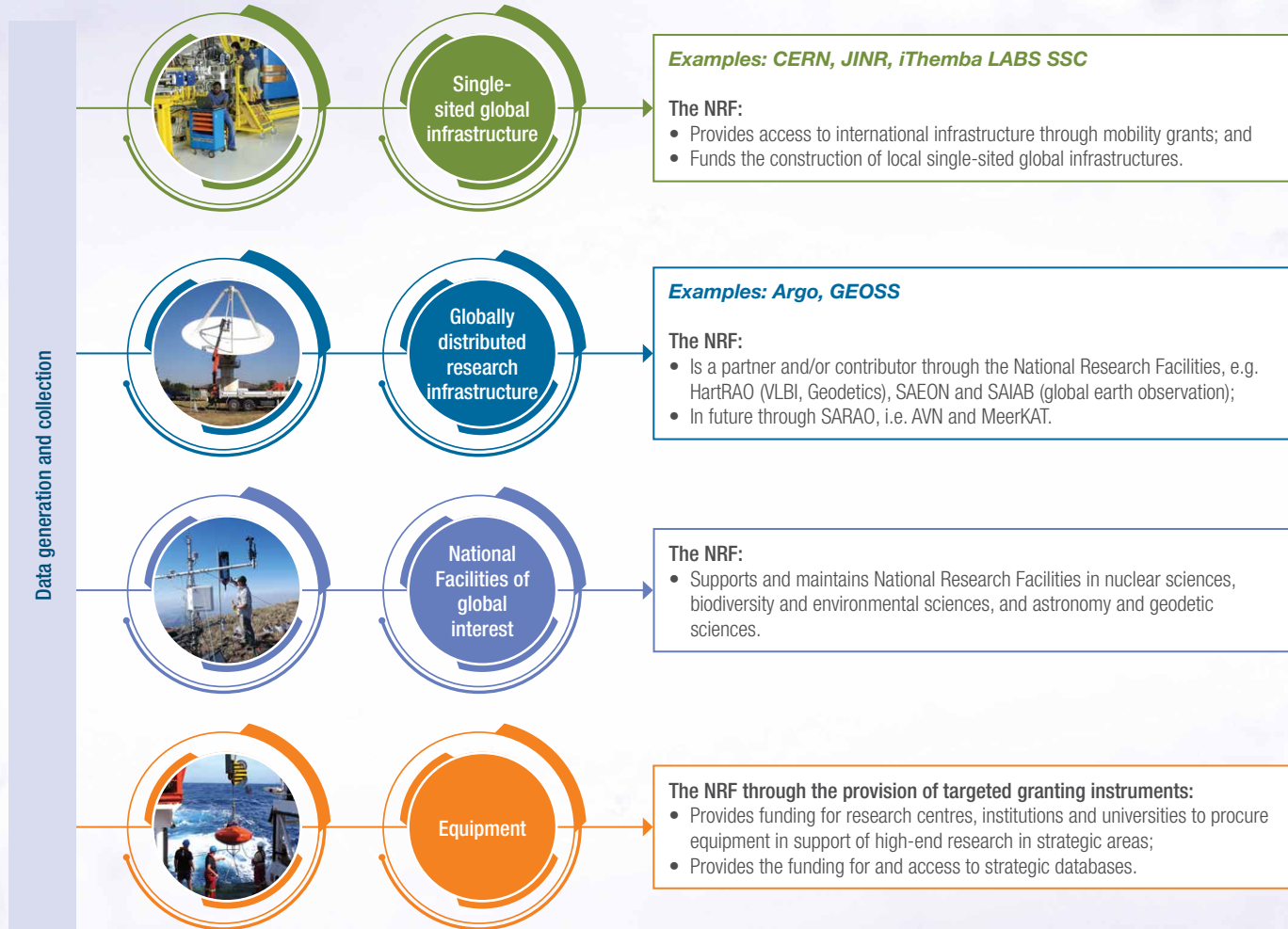
Figure 17 is a schematic of the typology of research infrastructure. In this regard SARIR (refer page 69) classifies infrastructure into four broad categories, namely:

- Single-sited global RIs are unique, geographically localised facilities where governance is fundamentally international in character.

The NRF enables access to single-sited RI through:

- The brokering of bilateral country-to-country agreements with the support of the DST;
- Supporting inter-institutional collaborative agreements; and
- The provision of mobility grants to allow for dynamic exchange between local and international researchers (refer to page 69);
- Globally distributed RI constitutes national or institutional nodes, which are part of a global network, and where governance is fundamentally international in character. While there is an element of mobility, the primary commodity is the access to data. In this context the NRF supports:
 - The sharing of collection and observation data with the global science networks.
- National Facilities of global interest are facilities with unique capabilities that are significant contributors to the global research network. The NRF is mandated to support and maintain the National Research Facilities (NFs) in South Africa as declared under the NRF Act.
 - In addition to providing a suite of NFs in the fields of nuclear science; biodiversity, conservation and environmental sciences as well as astronomy and geodetic sciences; the NRF also provides access to global national facilities through mobility grants in support of collaboration.
- Equipment and data provisioning to address the needs of specific research interest groups.
 - The provisioning of research equipment within the NRF is executed through its grant-making division (RISA) and aims to provide cutting-edge small to medium-sized equipment at the National Research Facilities, science centres and the universities.

Figure 17: Research infrastructure platforms map



11.1.2 RESEARCH DATABASES

Research conducted by large-scale infrastructure platforms generates very large volumes of data. It is therefore becoming essential to manage the protocols of hosting, securing, accessing, and preserving these data to provide researchers with findable, accessible, interoperable, and re-usable (FAIR) data, ideally in support of open science.

Over the MTEF period, the NRF, through its various business units, will continue to develop the capacity and expertise to support the development of protocols that will enable the creation of a national research data cloud. In this respect, SKA SA has been working on data solutions to process the vast quantities of data produced by MeerKAT and later the SKA. The processing of this data pipeline requires very high-performance central supercomputing. The scientific image and signal processing for radio astronomy imaging requires several fundamental processes, that must be executed across each dish (MeerKAT has 64) simultaneously or in sequence. The algorithms developed, support decisions on objects of interest, and remove data identified as having no scientific benefit, such as the radio frequency interference, which must be done in real time. Supercomputing will play an important role in the processing, storage and transfer of radio astronomy data.

11.1.3 NATIONAL RESEARCH FACILITIES

In terms of the proposed amendments to the NRF Amendment Bill 2016, a National Research Facility is an institution that provides unique and substantial infrastructure, capabilities and services for competitive research, innovation, and human capital development in science, engineering and technology. The main criteria for the evaluation and establishment of National Research Facilities are:

- A unique position in South African knowledge production;
- The offer of core technologies, research methodology or data pools/collections that should live up to international standards;
- Goals that are well-aligned with the overall objectives of the NSI, especially with regard to the diffusion of new knowledge;

- A critical mass of equipment, skills and users;
- Potential for networking and for attracting international collaborators to South Africa;
- The ability to provide opportunities for human resource development, with special efforts to involve researchers from formerly disadvantaged communities; and
- The ability to provide opportunities for the advancement of science and for the interface between science and society.

The NRF currently supports and maintains the National Research Facilities in the following areas:

- Nuclear science,
- Biodiversity and environmental science, and
- Astronomy and geodetic sciences.



11.2 NUCLEAR SCIENCE

The iThemba Laboratory for Accelerator Based Sciences (iThemba LABS) is the premier nuclear research facility within the NSI and in the African continent which offers accelerated particle beams towards the advancement of its transdisciplinary research agenda and the production of isotopes for use in research and medical sciences. The nuclear sciences not only endeavour to illuminate the structure and origin of matter that constitutes our universe, but also apply basic research in the physical, medical and biological sciences into knowledge that solves real-world problems. In this regard the work of iThemba LABS complements astronomy research undertaken by SAAO and SARAO.

The research agenda is underpinned by a number of sub-atomic particle accelerators, which include:

- A variable-energy separated sector cyclotron (SSC), which produces a wide variety of high-energy particle beams (proton energies of up to 200 MeV) and includes the two injector cyclotrons;

- A 6 MV tandem accelerator for accelerator mass spectrometry (AMS), ion beam analysis (nuclear microprobe and a spectrometer for heavy ions), as well as a beam-line devoted to low-energy nuclear reaction physics and astrophysics; and
- A 3 MV tandetron accelerator equipped with end stations for ion beam analysis techniques.

The SSC is pivotal to nuclear physics research, radioisotope production, radiobiology research related to particle therapy, and applications such as radiation hardness testing of electronic components used in satellites and detector calibrations, whilst the 11 MeV cyclotron is dedicated to the production of the radioisotope Flourine-18, used at local nuclear medicine facilities for imaging purposes.

The Material Research Laboratory applies the newly acquired 3 MV tandetron accelerator and refurbished beam lines to conduct research in nanosciences, nanotechnology, and thin film physics using material characterisation and modification with radiation and scanning probe microscopy.

Figure 18: Nuclear research infrastructure



The Accelerator Mass Spectrometry Laboratory's EN Tandem accelerator enables atomic mass spectrometry research related to radio-carbon analysis. Over the MTEF period, iThemba LABS will focus on the implementation of a long-range plan to enhance its science capabilities.

This will be achieved through, among others:

- Acquiring a new 70 MeV cyclotron that will contribute to:
 - Increased beam time availability for research (capacity will increase by a factor of three); and
 - Increased radioisotope production.
- Development of new research fields and applications including:
 - Research into new and innovative solutions for cancer treatment and early diagnostics;
 - Radiation hardness testing for the space sciences;
 - Research into the development of nanomaterials;
 - A doubling of the number of postgraduates supported by the facility; and
 - Fundamental research into sub-atomic physics to obtain an understanding of the astrophysical origin of the elements.
- Reconfiguration of the former medical radiation and radioisotope production departments into one unit focused on nuclear medicine research, radiobiology research and development of Theranostics (therapeutic-diagnostic) radioisotopes with short half-lives, such as alpha emitters;
- Upgrading the AFRODITE array with seven new Clover detectors, and acquisition of new array technologies such as the fast timing LaBr3 array, the African LaBr3 array (ALBA), and the Doppler shift attenuation method (DSAM) facility. These will enable the researchers to conduct high-impact experiments, as well as conduct research in radiation hardness of electronic devices that can be used in satellites and space applications.

11.2.1 NUCLEAR SCIENCE CONTRIBUTION TO STRATEGIC OBJECTIVE 1: PROMOTE GLOBALLY COMPETITIVE RESEARCH AND INNOVATION

The unique research platforms and skilled human resources at iThemba LABS form an integral part of the local and global research network. The facility produces world-class research outputs and services, and provides an opportunity for training South Africans and Africans in a wide range of accelerator-based science fields. iThemba LABS collaborates with 19 of the 25 universities in South Africa and is the point of coordination for a number of significant global collaborations including the agreements with CERN and JINR.

INCREASE AND PROVIDE SUPPORT FOR HUMAN CAPACITY DEVELOPMENT

During the MTEF period, staff at iThemba LABS will supervise or co-supervise on average 130 postgraduate students per year. In addition, a similar number of students from South African universities as well as from the rest of the continent will use the facility. A South African Institute of Nuclear Technology and Sciences (SAINTS) will be established to consolidate all the training initiatives in the Laboratory. Staff learning and development initiatives, courses for masters and doctoral programmes, short courses for professional development and international schools and workshops will be coordinated under the umbrella of SAINTS. iThemba LABS will collaborate with the French National Institute for Nuclear Science and Technology (INSTN) to develop training courses for SAINTS.

The iThemba LABS Master's programme in nuclear and material sciences (MANuS/MatSci Programme), in partnership with the University of the Western Cape (UWC) and the University of Zululand (UniZulu), will be expanded to include the Botswana International University of Science and Technology. As the premier African facility

for sub-atomic physics, opportunities are continuously explored to expand training opportunities to the rest of the continent. The new tandemron accelerator will provide another opportunity for postgraduate projects across Africa.

Research staff at the facility present lectures on radiation oncology and radiation biology, as well as courses for radiographers-in-training at technical universities. The recent funding for the LERIB feasibility study and ion source test set-up is expected to provide projects involving approximately 14 masters and doctoral students over the MTEF period and beyond.

SUPPORT MULTIDISCIPLINARY RESEARCH AND INNOVATION

The transdisciplinary research agenda at iThemba LABS supports a range of research domains including nuclear physics, materials research, radiation biology, radioisotope research and development, as well as the production and the use of radioisotopes and radio pharmaceuticals.

A. Nuclear physics

This research agenda is largely influenced by the availability of beam time on the separated sector cyclotron and by the major detector systems as outlined below:

The K600 spectrometer concentrates on research that is accessible by studying scattering and reactions produced by light ions at energies of up to 200 MeV/u. The infrastructure investment to improve the K600 spectrometer has allowed users to investigate clustering in nuclei and the properties and decay modes of giant resonances. The operation of the spectrometer will continue to provide unique opportunities, particularly with the recent addition of the capability to measure in coincidence both particles and gamma rays with high-energy resolution.



- The AFRODITE array of gamma detectors focuses on gamma-ray spectroscopic studies of nuclear structure, typically with heavy ion beams at up to a few tens of MeV per nucleon. Funding was obtained from the NRF through the Strategic Research Infrastructure Grant (SRIG) programme to supplement the present nine 'clover type' gamma detectors with three additional detectors. In parallel, a university consortium led by UWC has applied for funding for a further five clover detectors that would complete the array. With the full 16 detector array, the improved efficiency and sensitivity will expand the field of research by allowing the study of more weakly populated reaction channels.
- iThemba LABS staff participates in the ALICE collaboration at the CERN Large Hadron Collider (LHC), where they contribute to the maintenance and operations of the Forward Muon Spectrometer and related physics topics. These activities fall under the ALICE Physics Working Group. Staff also contributes to the ALICE-run coordination and central systems at the LHC Point 2 where the ALICE detector is located. The group is also contributing towards the ALICE upgrade programme, which facilitates technology transfer to scientists and technical staff to implement similar infrastructures locally.
- Over the reporting period, projects in the environmental radiation laboratory include the measurement to determine the amount of uranium in coal mines using conventional γ -ray spectrometry and/or neutron activation analysis. Radiological baseline assessment of ground-water in the Karoo Basin region will be conducted prior to the exploration for shale gas by the hydraulic fracturing method. In addition, γ -ray and radon air measurements in the Huguenot tunnel will be conducted as part of a feasibility study for an underground laboratory in South Africa.

B. Radiation biology

Research in molecular and cellular radiation biology supports the particle therapy (neutrons and protons) programme at iThemba LABS as well as conventional gamma therapy and the applications of

radionuclides and radiopharmaceuticals in therapy and diagnostics, including radiation protection. iThemba LABS further contributes to projects funded by the Nuclear Technologies in Medicine and Biosciences Initiative (NTeMBI), which include:

- The development of novel radio-surgical methods to study *in vivo* radiation damage in small tissue volumes, carried out in collaboration with the Catholic University of Louvain in Brussels, Belgium and the UFS.
- The study of radio-sensitisation of neutron and photon cellular damage using gold nanoparticles, in collaboration with UWC.
- Investigation of gene mutations in relation to radiation-induced apoptosis by photons and neutrons, and to study DNA repair foci as markers for radiation bio-dosimetry, with CPUT and NWU.
- The study of chromosomal radio-sensitivity of cervical cancer patients, triple negative and young breast cancer patients, and Fanconi anemia patients, as well as the influence of HIV in human lymphocytes on neutron radiation.
- Support of radiobiological detection of oncothermia to chemo-radiation therapy in HIV-positive cervical cancer patients.

C. Radioisotope production

This involves targetry development and modelling, chemical processing, radiolabelling, and production, dispensing and quality control processes together with current good manufacturing principles (cGMP). In this area iThemba LABS will continue to do the following:

- Extensive work around the development of new compounds labelled with ^{123}I , ^{68}Ga and ^{18}F ;
- Improved production and chemical separation processes for ^{68}Ge , used in the $^{68}\text{Ge}/^{68}\text{Ga}$ generator;
- The completion of the $^{82}\text{Sr}/^{82}\text{Rb}$ project, which involves the development and chemical processing of rubidium metal targets over the next 24 months. This project could realise a twofold increase in revenue relative to current ^{82}Sr sales;
- Commence with the development of alpha-emitting radiopharmaceuticals, which are highly desirable for cancer



therapy. The two high-demand radiopharmaceuticals in this regard are ^{225}Ac and ^{211}At ;

- Collaborative work limited to the NTeMBI programme and ad hoc arrangements with nuclear medicine departments at local hospitals and universities;
- Continued involvement in the UCT-Positron Emission Particle Tracking project as a radionuclide supplier and in a supervisory capacity.

11.2.2 NUCLEAR SCIENCE CONTRIBUTION TO STRATEGIC OBJECTIVE 2: ENHANCE STRATEGIC INTERNATIONAL ENGAGEMENTS

PROMOTE SYSTEM-WIDE INTERNATIONAL ENGAGEMENT AND EXPLOIT INTERNATIONAL RESEARCH PLATFORM ACCESS

iThemba LABS has a number of formal agreements with international institutions. In addition, a large number of informal collaboration agreements exist, some supported by NRF and DST bilateral funding programmes. These agreements, that benefit the South African research community, normally serve to fund research visits and collaborative research (from and to South Africa) as well as attendance at international events. These agreements include:

A. Conseil Européen pour la Recherche Nucléaire – CERN (European Organisation for Nuclear Research)

- The SA–CERN Consortium (which includes SA collaborators at ATLAS, ALICE, ISOLDE and Theory) collaboration has contributed to the formation of a South African research partnership, effectively creating a distributed research laboratory across South Africa as well as the establishment of a grid computational network linking all physics institutes. The SA–CERN consortium continues to strengthen the local research community by creating links between research institutes and academia in South Africa and the rest of the world.

- The SA–CERN contract with the DST has been renewed with a substantial increase in funding over the MTEF period. The programme has a management structure, the SA–CERN Consortium, with iThemba LABS as the host institution responsible for coordinating CERN initiatives on the African continent. In the future, more technology and know-how transfer will be targeted as part of the collaboration with CERN.

B. Joint Institute for Nuclear Research (JINR)

The key objectives of this collaboration are the promotion of joint research for SA–JINR researchers, of human capital development with emphasis on student training and technology, and knowledge transfer. Due to associate membership at the JINR, South Africa has observer status on the Committee of Plenipotentiaries (CoP) of the governments of the JINR member states, which is the highest decision-making body of the Institute. The funding transferred to JINR is used for hosting SA researchers and students in Dubna, Russia, infrastructure development, the student practice, and mobility of JINR researchers to SA. The local portion of the SA-JINR budget is used to provide mobility support for SA researchers and students to Dubna, Russia as well as small research grants for local-based SA-JINR collaborative projects. iThemba LABS, as the largest research infrastructure in sub-atomic physics on the African continent, will coordinate the collaboration with JINR on behalf of the African research community.

C. South African Institute of Nuclear Technology and Science (SAINTS)

The facility intends to consolidate the training programmes by establishing a South African Institute of Nuclear Technology and Sciences (SAINTS). SAINTS will offer taught MSc courses to

complement the current MSc programmes at the South African universities, with the aim of addressing the practical and theoretical skills required for MSc and PhD programmes. iThemba LABS currently collaborates with 13 institutions in Africa. Over the MTEF period, this collaboration will be formalised and supported through the SAINTS programmes in which iThemba LABS will play the role of ‘gateway’ to nuclear studies on the continent. Through SAINTS, iThemba LABS contributes to the objectives of STISA 2024, for which specific synergies are noted between the science granting councils’ initiatives and the objectives of SAINTS. Over the MTEF period, these synergies will be explored.



11.2.3 NUCLEAR SCIENCE CONTRIBUTION TO STRATEGIC OBJECTIVE 4: ESTABLISH AND MAINTAIN RESEARCH AND INFRASTRUCTURE PLATFORMS

iThemba LABS is the only accelerator-based nuclear facility in Africa and is classified as providing single-sited global research infrastructure in the context of SARIR. Over the MTEF period, iThemba LABS will continue to provide leading-edge research infrastructure to the continent and the world. In terms of its contribution to strategic objectives, iThemba LABS will:

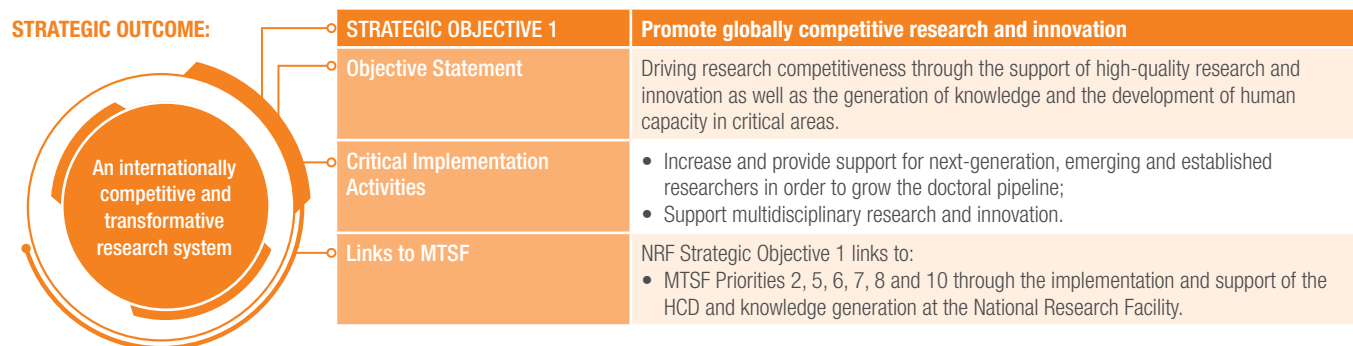
- Adopt a new strategy for infrastructure provisioning in support of globally competitive research and human capacity development. This will result in the creation of a South African Isotope Facility that is based on:
 - The establishment of the Accelerator Centre for Exotic Isotopes (ACE Isotopes), which will allow for the migration of the radioisotope production programme from the existing particle accelerator (the SSC) to a new cyclotron. This will release capacity on the existing SSC to be entirely devoted to the transdisciplinary research agenda of the facility, which will thus meet the requirements of its national and international stakeholders. This will include the supply of isotopes to local and international markets, which will increase fivefold;
 - The development of the Accelerator Centre for Exotic Beams (ACE Beams), which will provide accelerated, artificially produced isotopes for research. The production of these exotic beams will invigorate basic and applied research from innovative cancer therapy treatment modalities to understanding the origin and creation of chemical elements in the Universe;
 - The implementation of the strategy requires the acquisition of a dedicated, high beam current 70 MeV cyclotron. The

necessity of a new 70 MeV cyclotron was informed by a robust assessment of the facility operations and science plan. Over the MTEF period the facility aims to work towards funding Phase 1 of the project, i.e. ACE isotopes. In addition, the Rare Ion Beam Target and Ion source, funded from the SRIG programme (R32 million), will be installed and developed into a Low Energy Rare Ion Beam (LERIB) facility.

- Replacement of the low-level radio-frequency (RF) control systems of all RF amplifiers with digital control systems; and
- Beam development on the GTS2 ECR ion source as per the CERN collaboration agreement.

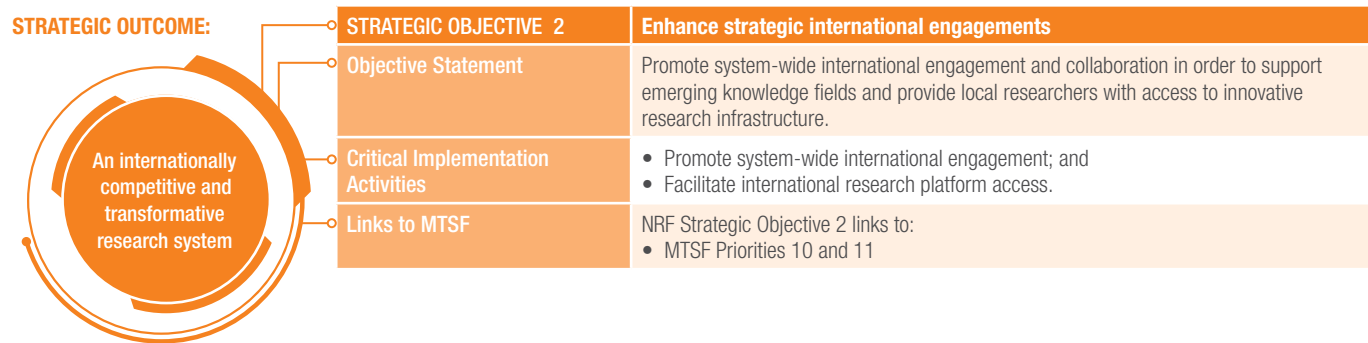


Table 18: Nuclear science – KPIs against budget (2018/19–2020/21) – Strategic Objective 1



INDICATORS	Actual 2015	Actual 2016	Actual 2017	Target 2018	Proj. 2019	Proj. 2020	Proj. 2021
Number of postgraduate students supported by the National Research Facilities	228	220	234	251	289	310	325
Web of Science (ISI) publications by researchers at the National Research Facilities	145	136	141	120	150	160	170
Number of users of National Research Facilities	515	515	454	475	505	520	525
Citation impact of National Research Facility outputs (annual cumulative)	>1	1.25	1.63	2	1.64	1.65	1.65
BUDGET (R million)	Actual 2015	Actual 2016	Actual 2017	Target 2018	Proj. 2019	Proj. 2020	Proj. 2021
Globally Competitive Research	76,860	92,849	166,777	87,958	86,555	88,463	92,116

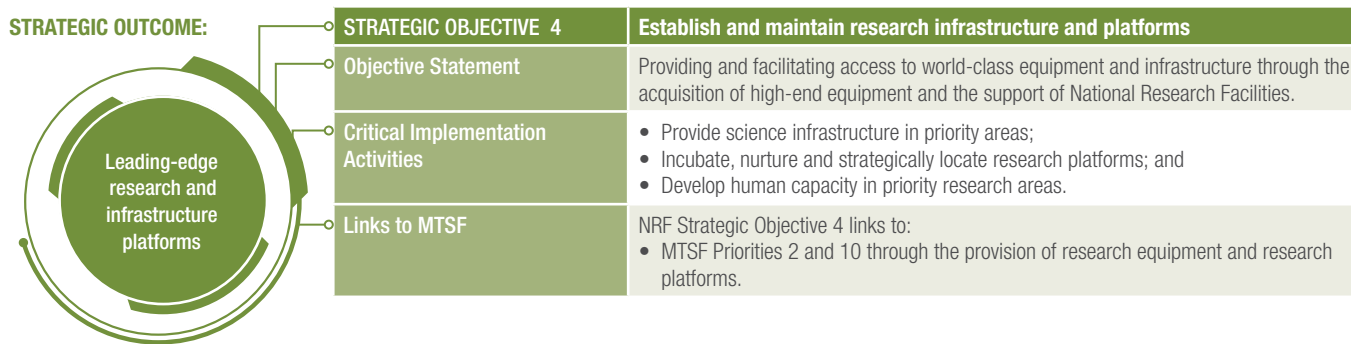
Table 19: Nuclear science – KPIs against budget (2018/19–2020/21) – Strategic Objective 2



INDICATORS	Actual 2015	Actual 2016	Actual 2017	Target 2018	Proj. 2019	Proj. 2020	Proj. 2021
Number of joint international agreements at the National Research Facilities	26	29	28	28	40	42	45

BUDGET (R million)	Actual 2015	Actual 2016	Actual 2017	Target 2018	Proj. 2019	Proj. 2020	Proj. 2021
Internationalisation	11,215	13,947	15,786	20,058	25,492	25,492	25,492

Table 20: Nuclear science – KPIs against budget (2018/19–2020/21) – Strategic Objective 4



INDICATORS	Actual 2015	Actual 2016	Actual 2017	Target 2018	Proj. 2019	Proj. 2020	Proj. 2021
Total infrastructure investment in the National Research Facilities (R million)	19,98	37,92	94,62	95	45.45	18.93	18.17

BUDGET (R million)	Actual 2015	Actual 2016	Actual 2017	Target 2018	Proj. 2019	Proj. 2020	Proj. 2021
Platform and infrastructure provision	123,785	175,597	347,346	237,720	186,405	168,295	177,305

The budget includes Capex and operational/support costs.

11.3 BIODIVERSITY AND ENVIRONMENTAL SCIENCES

The NRF has two national facilities operating in this area of research, namely the South African Institute for Aquatic Biodiversity (SAIAB), and the South African Environmental Observation Network (SAEON). The complementary nature of their science agendas and the commonality of purpose allow these facilities to work closely in support of achieving the strategic objectives in this research field.

The NRF has been identified as the most suitable host for the Expanded Terrestrial and Freshwater Environmental Observation Network (ETFEON) and the Shallow Marine and Coastal Research Infrastructure (SMCRI) under the SARIR programme. It is proposed that both be embedded in SAEON, as its existing six nodes overlap

with both these infrastructures and will be instrumental in their rapid establishment and running. The NRF will have fiduciary control over both SMCRI and ETFEON through its Board, and the RIs will be required to adhere to its policies and regulations.

ETFEON will provide impetus to SAEON's eco-hydrological research with a focus on monitoring the flow of water in streams and rivers within the major catchments in the country. The programme will establish a South Africa-wide platform for interdisciplinary research on eco-hydrology to understand the impact of land-use, land management, and climate change on the supply of fresh water. Through ETFEON, atmospheric carbon fluxes will also be monitored to gain insight into these cycling processes.

SMCRI aims to enhance ecosystem-wide multidisciplinary research. SMCRI will require the deployment of a network of oceanographic sensors which, together with the collection of lower trophic data (phytoplankton and zooplankton), will enable researchers to better interpret and contextualise results. Through SMCRI, both SAEON and SAIAB will collaborate with other research infrastructure projects such as ETFEON and the Marine and Polar Facility.

THE SOUTH AFRICAN INSTITUTE FOR AQUATIC BIODIVERSITY (SAIAB)

SAIAB provides scientific leadership and expertise in aquatic biodiversity that is vital to national interests when dealing with issues arising from exponentially increasing pressures of human population growth and development. The facility focuses on the full spectrum of African aquatic biodiversity, from marine offshore to continental freshwater catchments. The SAIAB research agenda includes:

- Conservation biology and ecology, which focuses on understanding aquatic biodiversity in order to inform the conservation of those resources; and
- Molecular biology and systematics, which is the exploration and description of Southern African biodiversity from the molecular to a faunal level.

SAIAB runs the African Coelacanth Ecosystem Programme (ACEP). This is a marine research platform which provides access to research infrastructure and associated funding to the research community to undertake research along the east coast of South Africa. ACEP is a flagship programme of the DST and the NRF. Its key partners are the Department of Environmental Affairs (DEA) (Oceans and Coasts), the Department of Agriculture, Forestry and Fisheries (DAFF), and SAEON. To ensure an open, transparent, and competitive funding structure, an open research call is distributed by the NRF every three years. The ACEP marine platform enables successful applicants to sample the entire coastal ecosystem from physical oceanography, marine

geology, phytoplankton and zooplankton to animals burrowing into the marine sediment, fish, marine mammals, and birds from near-shore to 40 nautical miles offshore.

SAIAB actively engages in a range of national research interventions and provides research which is relevant to a range of different national priorities. SAIAB conducts research which is of use to, or is done in conjunction with, provincial conservation agencies, e.g. Cape Nature; national departments, e.g. DEA (Oceans & Coasts), DAFF and the Department of Water and Sanitation (DWS) through the Water Research Commission (WRC). Recent strategic interventions in which SAIAB has played a significant role are:

- Operation Phakisa – Oceans Economy (DST)
- Formulation of the Marine and Antarctic Research Plan (DEA)
- Drafting of the South African Marine Research Strategy (DEA)
- Steering Committee of the South African Research Infrastructure Roadmap (SARIR)
- Partner in the SARIR South African Marine and Coastal Research Infrastructure programme (SMCRI)
- Partner in the Natural Science Collections Facility (NSCF)
- National Biodiversity Assessment in partnership with South African National Biodiversity Institute – SANBI
- National Shale Gas Strategic Environmental Assessment (SANBI)

SAIAB's research infrastructure and equipment are clustered into three main areas:

Marine infrastructure

- **Coastal Craft Fleet:** Specially designed boats (9 – 15m) capable of working in South African marine conditions. Vessels are based in Port Elizabeth, Grahamstown and Durban. A suite of specialised marine equipment is operated off each of these vessels. The fleet has a highly trained crew of skippers, instrument operators and deckhands.

- **Marine Remote Imagery Platform (mar-RIP):** A suite of remotely (tethered and untethered) imagery platforms that operate between 1 and 800 m. These units take high definition pictures and video feed. mar-RIP holds the national archive of images.
- **Acoustic Telemetry Array Platform (ATAP):** ATAP is South Africa’s contribution to the international array run through the Global Ocean Tracking Network (OTN). The platform is made up of over 100 *in situ* receiver stations on the seabed between the depths of 1 m and 80 m. The receivers are distributed between Cape Town and Mozambique. ATAP manages the South African database that links with the OTN data system.
- **Marine Geophysics Platform:** A multi-beam sonar for seafloor mapping (5 – 200 m) geo-positioning referencing system. Both systems are fitted on the RV Phakisa but can also be used off RV Jahleel.

Collections and associated specialist laboratories

- **National Fish and Diatom Collections:** Fish and diatom collections are housed in a bespoke facility of international standard. Collections of other taxa are growing. All collections

are databased and actively curated.

- **Aquatic Genomics Research Platform (AGRP):** A molecular laboratory that is equipped to do most current genetic and molecular analyses including next-generation sequencing.
- **Aquatic Ecophysiology Research Platform (AERP):** The Ecophysiology laboratory specialises in temperature, salinity and carbon dioxide manipulated physiology studies. The laboratory aims to answer specific climate change-related questions with respect to organism physiology.

Information platform

- **IT server backbone:** Servers, storage space and excellent IT support.
- **Margaret Smith Research Library:** A specialised aquatic science research library and archive.
- **Aquatic Biodiversity Informatics – Databases:** NRF-SAIAB manages and hosts some internationally and nationally important databases - e.g. National Fish collection - Specify database; National Telemetry database; and National Aquatic Video archive.

Figure 19: Examples of SAIAB research infrastructure



SOUTH AFRICAN ENVIRONMENTAL OBSERVATION NETWORK (SAEON)

SAEON is a comprehensive, sustained, coordinated and responsive national network of *in situ* environmental observatories that delivers long-term reliable data for scientific research; and informs decision-making for a knowledge society and improved quality of life. SAEON offers public value through long-term multi-disciplinary observation programmes, research infrastructure and platforms that are designed to clarify earth system dynamics and changes over multiple scales, and to distinguish between natural and anthropogenic environmental change. Public value is also created through the development of open-access data systems and tools. The entity is managed as a National Research Facility, though discussions to declare it as such officially are pending.

The mandate of SAEON is to serve as the national platform for detecting and translating environmental change, and for predicting the impact of such change on terrestrial and marine ecosystems. The mandate is discharged by establishing and maintaining state-of-the-art observation and monitoring sites and systems; driving and facilitating research on long-term change of South Africa’s terrestrial biomes, coastal and marine ecosystems; developing and maintaining collections of accurate, consistent and reliable long-term environmental databases; promoting access to data for research and/or informed decision-making; and contributing to capacity building and education in environmental sciences.

Since the Southern African indigenous biodiversity, landscapes and oceans are continuously changed by diverse and adjoining land uses such as mining, farming, conservation, forestry, urban sprawl, communal resource management and fishing, time-series data covering the spectrum of spatial scales is essential for reliable observation of environmental changes. While some of these are slow, others may be sudden. Further, advanced climate change is already being observed, however, predictive capabilities with respect to impact remain uncertain. Rural communities are particularly vulnerable to climatic

variability, which is often aggravated by unsustainable agricultural and fishing practices.

Several Acts of parliament and government strategies depend directly or indirectly on environmental monitoring and research. Among these are:

- The Conservation of Agricultural Resources Act (Republic of South Africa 1984),
- Marine Living Resources Act (Republic of South Africa 1998a),
- National Water Act (Republic of South Africa 1998b),
- National Forests Act (Republic of South Africa 1998c),
- National Environmental Management Act (Republic of South Africa 1998d),
- Minerals and Petroleum Resources Development Act (Republic of South Africa 2002),
- National Energy Act (Republic of South Africa 2008),
- White Paper on Science and Technology (Republic of South Africa 1996a),
- National Agricultural Research and Development Strategy (Department of Agriculture 2008),
- National Sustainable Development Strategy (Department of Environmental Affairs 2011), and
- National Climate Change Response Strategy (Republic of South Africa 2011).



SAEON consists of six geographically dispersed observation nodes as outlined below.

Figure 20: SAEON nodes



11.3.1 BIODIVERSITY AND ENVIRONMENTAL SCIENCES CONTRIBUTION TO STRATEGIC OBJECTIVE 1: PROMOTE GLOBALLY COMPETITIVE RESEARCH AND INNOVATION

INCREASE AND PROVIDE SUPPORT FOR HUMAN CAPACITY DEVELOPMENT

A. SAIAB

One of the National Facility's key successes is its supervision programme in support of postgraduate students. Over the last 10 years SAIAB has developed a thriving postgraduate school with some 60 students being supervised every year, despite the facility having only eight permanent staff researchers. The key objective over the MTEF period is to continue to transform the student demographics while continuing to focus on excellence.

Over the MTEF period, SAIAB will focus on the following:

- Ongoing transformation of the postgraduate school through aggressive target-setting and associated performance management of the research staff. Black South African students are preferentially secured and trained.
- The ACEP Phuhlisa programme: this is an external transformation initiative driven by SAIAB with historically black universities (HBUs). In its initial three-year period (2012–2014), Phuhlisa grew from eight to 26 postgraduate students. Contributing to transformation in marine science in South Africa is a key aim of ACEP as a whole and the Phuhlisa programme in particular. Through phased development, the Phuhlisa programme has proved to be a successful model for developing quality graduates in marine science. ACEP Phuhlisa supports HBU marine science researchers who gain access to National Facility research equipment and expertise through the programme. Financial assistance is provided

in the form of running costs for student research projects, as well as study bursaries where required. By the end of the third phase of ACEP in 2015, some 40 honours, MSc and doctoral students from the University of Fort Hare and Walter Sisulu University had been through the Phuhlisa programme, laying the foundation for the next phase of ACEP. The programme expanded in 2016/17 to include students from the University of Zululand and University of the Western Cape.

- SAIAB will officially launch its first SARChI in Inland Fisheries and Freshwater Ecology in 2018. This will see increased impetus in this important research area. It will also allow for additional posts to be created at the entry level that will be advertised in late 2018 and 2019 and will be filled by black South African doctoral graduates.

B. SAEON

Postgraduate students at SAEON are engaged with through specific internship and training programmes that focus on the science, data and information management programmes. Postdoctoral fellows are also supervised under the professional development programme (PDP). The numerous SAEON sites across the country act as living laboratories for postgraduate field schools and field trips. In addition, SAEON's education-outreach programme is focused on human capacity development. The programme focuses on exposing school learners to the actual science of environmental observation, data collection, analysis, reporting, and disseminating findings of hands-on projects.

Over the MTEF period, SAEON will focus on the following:

- Extending the SAEON education-outreach programme, which has been running at three of the six SAEON nodes; and
- Continuing with the SAEON Graduate Student Network, a structured forum for postgraduate students to facilitate interaction and sharing of ideas by way of multidisciplinary annual research training and conferencing.

SUPPORT MULTIDISCIPLINARY RESEARCH AND INNOVATION

For both SAEON and SAIAB to fully interpret the impact of climate and global change will require transdisciplinary research across various knowledge domains.

A. SAIAB

The primary science objective of SAIAB is to develop research projects and programmes on African aquatic biodiversity that provide platforms for student training and improve knowledge of aquatic biodiversity on the continent so that its considerable aquatic resources can be sustainably developed and conserved. These projects/programmes are broadly clustered under two major themes, namely: Conservation Biology and Ecology and Molecular Biology and Systematics. There is an increasing emphasis on involvement in multidisciplinary and multi-institutional research programmes as evidenced in the research activities planned for the MTEF period:

- Climate change research – New laboratory-based studies on the ecophysiology of coastal and estuarine invertebrate and fish species will be undertaken. Climate (temperature) and global change (fishing) effects on fish growth and distributions will be the focus of this research;
- The Barcode of Wildlife Project in collaboration with SANBI will see the establishment of a national reference library for DNA barcoding data for illegally traded and exploited aquatic organisms;
- In partnership with the KZN Sharks Board, a study on population genetics aims to use a suite of genetic markers to analyse and describe genetic diversity of sharks along the east coast of South Africa. The study will also analyse unidentified stomach contents of sharks and the biodiversity of associated copepods parasites using DNA barcoding;
- The Acoustic Tracking Array Platform (ATAP) is now fully operational and will be streamlined in terms of data collation and data sharing between 2018 and 2020. A number of new studies will be initiated, with a strong focus on coastal sharks, stingrays, and other important species. At least 30 researchers and students

from 14 research/academic institutions benefit from this initiative. The facility will also continue working with neighbouring countries (e.g. Mozambique and the Seychelles) on projects investigating the movements, habitat-use patterns and spawning aggregation dynamics of little-known tropical fish species;

- BioGaps is a collaborative research project involving several institutions (SAIAB, SANBI, ARC, SAEON, UCT, Stellenbosch University, Ditsong Museum, Iziko SA Museum, UKZN, American Museum of Natural History) that was initiated in 2016 to mobilise foundational biodiversity data on key taxa to support strategic environmental assessments for shale gas development and other infrastructure development projects in the Karoo and adjacent regions;
- Genetic stock assessments – This is a multi-disciplinary project that will incorporate genetics, ecological niche modelling and biological studies of a number of commercially important South African linefish species in order to predict the effects of climate change. This will be performed to identify suitable parameters for implementing a management system responsive to climate change and to build capacity in these fields;
- The Marine Remote Imagery Platform (mar-RIP) is now widely utilised across the continental shelf of South Africa. Over the next three years the platform aims to begin conducting research in deeper benthic habitats away from the continental shelf to further map biodiversity hotspots and critical habitats for conservation;
- Coastal research – In the last decade, the coastal platform at SAIAB has been largely utilised to progress the understanding of the mechanisms underlining the connectivity of marine populations. It is envisaged that this platform will continue to grow, due to recent infrastructure development that will extend the scope of coastal/nearshore research in terms of multidisciplinary, the generation of integrated knowledge and increased spatio-temporal resolution;
- Freshwater fisheries – SAIAB will expand its current research focus on freshwater fisheries to ensure the maximum socio-economic return to impoverished communities while maintaining

the ecological integrity of the resources. This research area will be supported by a new SARChI; and

- Freshwater invasion biology – Research in conjunction with the Centre for Invasion Biology, a DST/NRF CoE, will continue to drive research to better manage various invasive freshwater fish species in South Africa.

B. SAEON

SAEON's Core Science Framework guides its scientific outlook. Each of the SAEON nodes has developed its own science plans aligned to the Core Science Framework. The framework largely follows the DPSIR model (drivers, pressures, state, impacts and responses), which is a simplification of how the ecosystem changes as a result from cyclic interactions (Figure 21 on next page).

The observation and monitoring of environmental change provide for incremental advances in the understanding of ecosystems, and increase our ability to detect, predict and react to environmental change. The work encompasses intensive fieldwork and oceanographic work by scientists and technologists. Repeated observations at fixed locations on land or moored instruments at sea or by drifting instruments are undertaken. In support of this multidisciplinary agenda, the following programmes are offered:

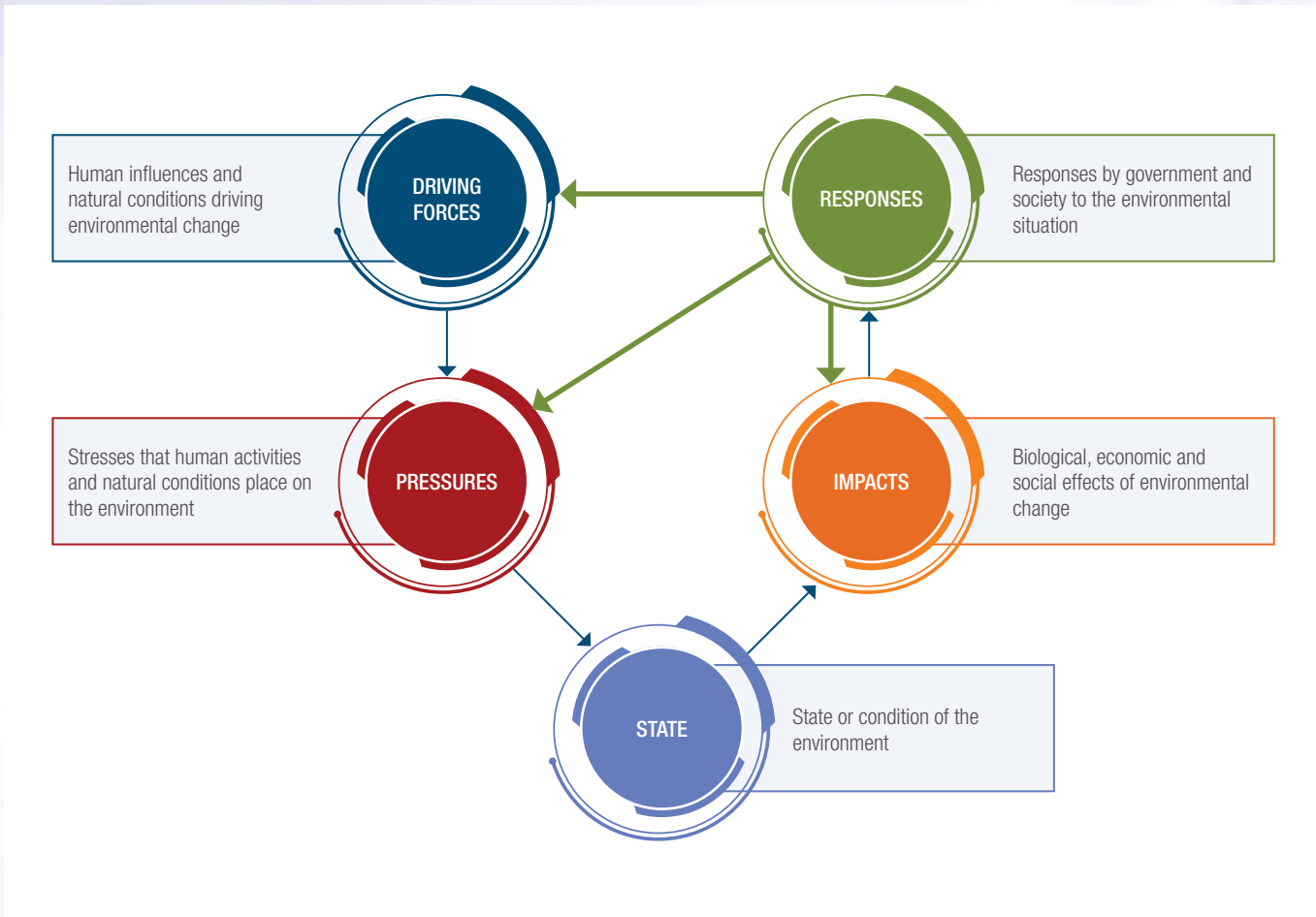
- The ETFEON will provide impetus to SAEON's ecohydrological research, which already received a boost from SRIG. The programme focuses on streamflow monitoring and will establish a country-wide platform for interdisciplinary research on the ecohydrology of water catchments to understand the impact of land-use, land management and climate change on the supply of fresh water. It will also continuously monitor atmospheric carbon fluxes to gain insight on cycling processes;
- Shallow Marine and Coastal Research Infrastructure will provide a platform to enhance ecosystem-wide research that is multidisciplinary in nature. The sensors that will be deployed by the SMCRI are largely oceanographic in nature, which, together

with the collection of lower trophic data (phytoplankton and zooplankton) will enable researchers from universities and other research entities to better interpret and contextualise their results; and

- The coastal zone is also at the receiving end of terrestrial and offshore inputs, requiring SMCRI to work closely with collaborators and other RIs (ETFEON) active in those domains. To fully understand the impact of climate and global change transdisciplinary collaboration, especially with socio-economic and socio-ecological scientists and RIs (e.g. Health and Demography RI) will be required.



Figure 21: Ecosystem changes as a result of cyclic interactions



11.3.2 BIODIVERSITY AND ENVIRONMENTAL SCIENCES CONTRIBUTION TO STRATEGIC OBJECTIVE 2: ENHANCE STRATEGIC INTERNATIONAL ENGAGEMENTS

The cluster has established numerous international partnerships, which has greatly facilitated the movement of researchers and students between South Africa and its international partners, thereby ensuring that research activities are at the forefront of the latest developments in these fields of study.

PROMOTE SYSTEM-WIDE INTERNATIONAL ENGAGEMENT AND EXPLOIT INTERNATIONAL RESEARCH PLATFORM ACCESS

A. SAIAB

The facility has collaborations with institutions in 16 countries. The major collaborations involve:

- CSIRO (Australia) on marine fish systematics and the University of Western Australia on freshwater crustacean taxonomy;
- The Universidade Federal do Paraná (Brazil) – collaboration on alien invasive fishes;
- Dalhousie University of Canada, to maintain a network of acoustic receivers for the long-term monitoring of marine animal migration under the auspices of the global Ocean Tracking Network project;
- Collaboration on epigenetic research with Universidad Pontificia de Chile;
- An agreement with the EU to enhance knowledge of aquatic ecosystems that support fisheries, development of integrated strategies for sustainable fisheries and improved fisheries management;
- A longstanding partnership with the Norwegian Institute for Nature Research (NINA) through the South Africa–Norway Research Cooperation on Climate Change (SANCOOP) programme, funded by the Norwegian Research Council and the NRF;
- Research collaboration and student involvement with the

Seychelles Fishing Authority and research collaboration with the Save Our Seas Foundation (SOSF) D’Arros Research Centre at St Joseph Atoll;

- University of Florida and Lincoln University on centrarchid genetics and ecology in SA and the USA; and
- Institute of Estuarine and Coastal Studies, Hull University (UK) to collaborate in undertaking research, teaching and scientific awareness in many fields of aquatic ecology and biodiversity.

B. SAEON

The facility has been a member of the International Long-Term Ecological Research Network (ILTER) for more than a decade. Staff at SAEON serve on the ILTER executive and science committees. A large proportion of SAEON’s international activities have been in data and information management. These activities are to continue in the MTEF period and include the following:

- Participation in Group on Earth Observation (GEO) symposia and workshop activities as part of support for the South African chapter of GEO (SAGEO) and South African Earth Observation Strategy (SAEOS); and in the European Group on Earth Observation System of Systems (GEOSS) programmes;
- Participation in the programmes of ICSU’s Committee on Data for Science and Technology (CoDATA) and World Data System Scientific Committee;
- Participation in the Research Data Alliance; and
- Collaboration with the Meraka Institute on the National Integrated Cyber Infrastructure System (NICIS).

SAEON is the only non-library institution accredited to manage digital object identification (DOI) systems. Through this it will provide citation-linking services for the scientific publishing sector but intends to transfer this responsibility to the NRF Corporate. The facility will undertake to position the data portal and associated platforms, such as the SAEOS, BioEnergy Atlas, and Risk and Vulnerability Atlas, as important components of NICIS in which the NRF and SKA SA are expected to play a significant role.

11.3.3 BIODIVERSITY AND ENVIRONMENTAL SCIENCES CONTRIBUTION TO STRATEGIC OBJECTIVE 4: ESTABLISH AND MAINTAIN RESEARCH AND INFRASTRUCTURE PLATFORMS

PROVISION OF SCIENCE INFRASTRUCTURE IN PRIORITY AREAS

A. SAIAB

The facility provides three distinct research platforms to the research community. These are: the ACEP Marine Infrastructure Platform, the Collections and Specialised Laboratories Platform (Molecular, X-Ray, Biobank and Ecophysiology), and the Information Platform (Library and Biodiversity Informatics unit).

Over the MTEF period, SAIAB will:

- Acquire a new coastal research vessel to expand the established coastal craft fleet to have vessels in Durban, Port Elizabeth and False Bay. This expansion will be completed in conjunction with SMCRI.
- Recapitalise and grow the Acoustic Telemetry Array Platform and the Marine Remote Imagery Platform (mar-RIP).
- Increase collection storage capacity through completing the second floor of the collections building.
- Expand the Genetics Laboratory to include a new-generation sequencer, as well as expand the Aquatic Ecophysiology Laboratory, which is a shared resource with Rhodes University.

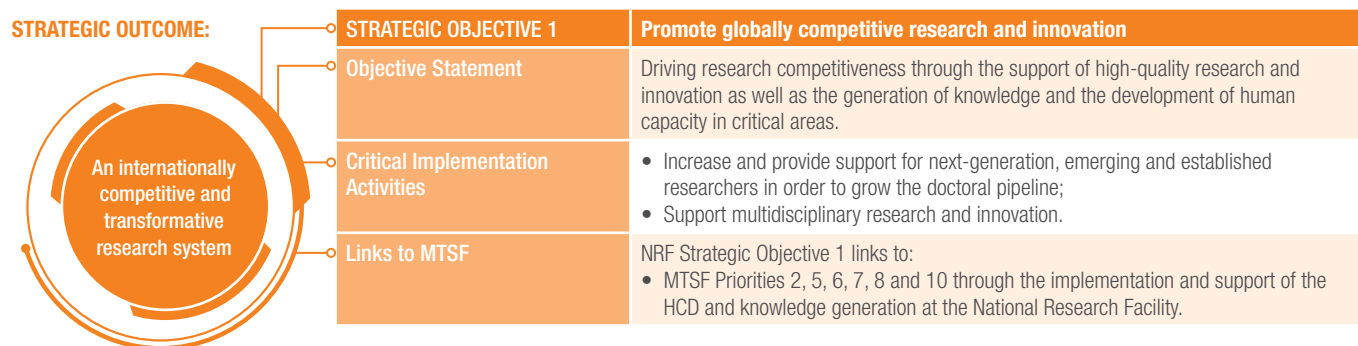
B. SAEON

The demand for the use of the research platforms in this area of research remains exceedingly high, with over 200 users (researchers and students) currently making use of the facilities. Over the MTEF period:

- SAEON will develop research infrastructure at the Tierberg Karoo Research Centre in Prince Albert. A property of approximately 100 hectares was donated to SAEON for use as a research centre.
- Larger and uniquely-placed environmental observation systems that will be maintained are the Algoa Bay sentinel site, the Agulhas System Climate Array, the Jonkershoek and Cathedral Peak core sites, the array of land and natural resource use research sites in Limpopo, the Tierberg LTER, and the grazing trials at Grootfontein. Tentative new sites, pending resources, are at the Square Kilometre Array, the Letaba Hydrological Observatory and the Lower Orange River system.



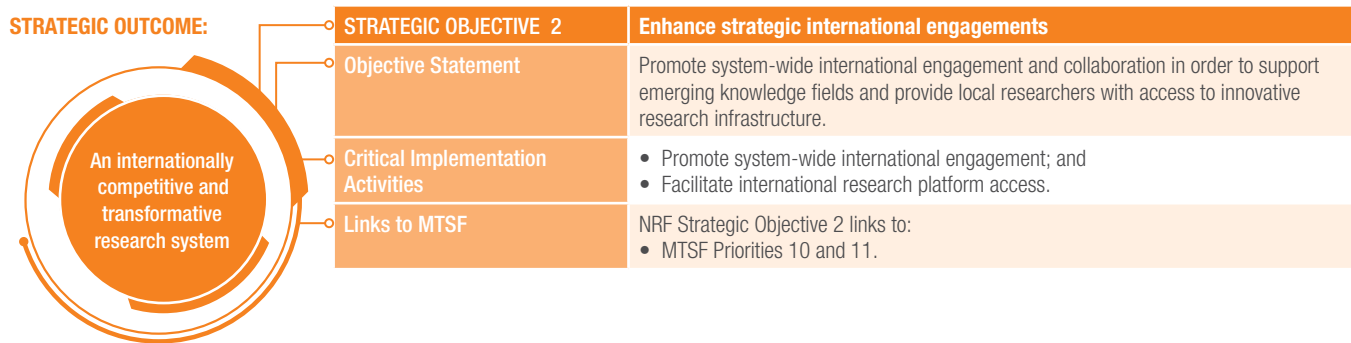
Table 21: Biodiversity and environmental sciences – KPIs against budget (2018/19–2020/21) – Strategic Objective 1



INDICATORS	Actual 2015	Actual 2016	Actual 2017	Target 2018	Proj. 2019	Proj. 2020	Proj. 2021
Number of postgraduate students supported by the National Research Facilities	223	240	320	238	235	240	245
ISI publications by researchers at the National Research Facilities	89	142	180	86	105	115	125
Number of users of National Research Facilities	580	708	716	556	562	580	600
Citation impact of National Research Facility outputs (annual cumulative)	1.01	1.21	1.19	1,2	1,2	>1,2	>1,3

BUDGET (R million)	Actual 2015	Actual 2016	Actual 2017	Target 2018	Proj. 2019	Proj. 2020	Proj. 2021
Globally Competitive Research	50,250	58,781	112,176	94,892	93,605	105,120	97,144

Table 22: Biodiversity and environmental sciences – KPIs against budget (2018/19–2020/21) – Strategic Objective 2




INDICATORS	Actual 2015	Actual 2016	Actual 2017	Target 2018	Proj. 2019	Proj. 2020	Proj. 2021
Number of joint international agreements at the National Research Facilities	28	38	28	32	21	23	25

BUDGET (R million)	Actual 2015	Actual 2016	Actual 2017	Target 2018	Proj. 2019	Proj. 2020	Proj. 2021
Internationalisation	1,646	1,064	311,859	1,279	1,770	1,013	738



Table 23: Biodiversity and environmental sciences – KPIs against budget (2018/19–2020/21) – Strategic Objective 4

<p>STRATEGIC OUTCOME:</p>  <p>Leading-edge research and infrastructure platforms</p>	STRATEGIC OBJECTIVE 4	Establish and maintain research infrastructure and platforms
	Objective Statement	Providing and facilitating access to world-class equipment and infrastructure through the acquisition of high-end equipment and the support of the National Research Facilities.
	Critical Implementation Activities	<ul style="list-style-type: none"> • Provide science infrastructure in priority areas; • Incubate, nurture and strategically locate research platforms; and • Develop human capacity in priority research areas.
	Links to MTSF	<p>NRF Strategic Objective 4 links to:</p> <ul style="list-style-type: none"> • MTSF Priorities 2 and 10 through the provision of research equipment and research platforms.

INDICATORS	Actual 2015	Actual 2016	Actual 2017	Target 2018	Proj. 2019	Proj. 2020	Proj. 2021
Total infrastructure investment in the National Research Facilities (R million)	17	31	40	81.40	41.00	33.56	24.08

BUDGET (R million)	Actual 2015	Actual 2016	Actual 2017	Target 2018	Proj. 2019	Proj. 2020	Proj. 2021
Platform and infrastructure provision	133,693	118,196	637,447	100,027	74,684	52,045	48,045

The budget includes Capex and operational/support costs.



11.4 ASTRONOMY AND GEODETIC SCIENCES

The National Research Facilities in the astronomy and geodetic sciences cluster provide platforms in support of the National Strategy for Multiwavelength Astronomy. The South African Astronomical Observatory (SAAO) provides optical astronomy observation capacity and is the premier optical and infrared facility on the continent. The South African Radio Astronomy Observatory (SARAO) is a geographically dispersed observatory focused on radio astronomy and geodesy.

OPTICAL ASTRONOMY

The SAAO is the national centre for optical and infrared astronomy in South Africa. Its primary function is to conduct fundamental research in astronomy and astrophysics. The SAAO operates a number of telescopes, including the Southern African Large Telescope (SALT). The latter is owned by the SALT Foundation, formed by an international consortium of institutions with the NRF as the major shareholder. The research agenda at the SAAO includes:

- Planetary astronomy, since the geographic position of Sutherland, combined with its high-speed instrumentation capabilities, makes

it a key location in the global context;

- Studies of interacting binary stars in order to advance the understanding of this class of object and provide the opportunity to explore a broad range of astrophysical phenomena, the most obvious being accretion;
- Transient events where SALT and the SAAO telescopes take full advantage of the opportunities that transients present from various ongoing and future surveys like CRTS, Pan-Starrs, Skymapper and LSST;
- Nearby Milky Way companions – SALT provides unique opportunities to study this area in more detail;
- Galaxy formation and evolution – SALT and the Infrared Survey Facility (IRSF) instruments are used to address the question of how galaxies form and evolve;
- Exoplanets;
- Galaxy clusters – which permit studies of the growth of the most massive structures in the Universe;
- Active galactic nuclei – as sources of variable extra-galactic objects; and
- Cosmology – here the work centres on exploitation of type 1a supernovae discovered as part of international collaborations.

Figure 22: The optical and infrared research infrastructure at Sutherland



RADIO ASTRONOMY

The South African Radio Astronomy Observatory (SARAO) was declared on 28 July 2017 and operates as a hub for radio astronomy, reinforcing South Africa's position as a key player in this field. The facility encapsulates various radio astronomy projects such as MeerKAT and AVN. The Square Kilometre Array (SKA) project is an international effort to build the world's largest radio telescope, with eventually over a square kilometre of collecting area. The scale of the SKA represents a significant advancement in both engineering and research and development towards building and delivering a unique instrument, with the detailed design and preparation now well under way. As one of the largest scientific endeavours in history, the SKA will bring together a wealth of the world's best scientists, engineers and policy-makers to bring the project to fruition. The SKA Organisation is made up of ten member countries, of which South Africa is one.

The Square Kilometre Array South Africa (SKA SA) has as its highest priority to design, construct, commission, and operate a world-class radio telescope which will include MeerKAT, which is targeted to be completed in 2018. Once commissioned, MeerKAT will be capable of transformational research in astronomy. As an official precursor instrument to the SKA, the MeerKAT telescope will be integrated into Phase One of the SKA Mid Telescope. In addition to MeerKAT activities, SKA SA is playing a strong role in the design of the SKA through international participation and consortia activities during the SKA Design Phase, as well as AVN development towards Phase Two of the SKA project.

The HartRAO site provides an international-standard open-access radio astronomy and space geodesy research platform for local and international users, capitalising on HartRAO's geographic advantage for these disciplines. In addition, activities at the HartRAO site includes the development of new instrumentation, new research platforms and new software in collaboration with higher education institutions.



Among SARAO’s strategic objectives are the following:

- Optimise South Africa’s contribution to, and benefit from, the international SKA project;
- Establish and sustain globally competitive and transformed radio astronomy and space geodesy research and infrastructure in South Africa and abroad, where appropriate;
- Optimise the associated national socio-economic benefit from radio astronomy and space geodesy activities; and
- Promote radio astronomy and space geodesy in Africa.

Over the MTEF period, the consolidation process will be implemented to ensure that the three phases as outlined below, are effectively realised:

- Phase 1: KAT-7 and CBASS will continue to operate while MeerKAT, AVN, the Hydrogen Epoch of Reionization Array (HERA) and other new instruments are under construction or being planned. This phase will be completed during the current MTEF period;
- Phase 2 (2018 to 2023): MeerKAT, HERA and AVN commissioning together with the consolidation of all non-university-based radio astronomy activities within SARAO; and

- Phase 3 (2023 onward): the period post SKA-1 commissioning. MeerKAT will be integrated into SKA-1, and it is anticipated that the NRF will be contracted by the international SKA Organisation, through SARAO, to manage the technical operations of the SKA telescope and site. The South African Tier 1 Data Node will be established as part of SARAO.

With the adoption of appropriate objectives and goals that flow from these strategic objectives, the new organisation will enable and facilitate the following efficiencies and opportunities:

- Shared resources for the design of new instrumentation;
- Access to skills and platforms across varied but related disciplines;
- Array and network-based science;
- Astronomical and geodetic VLBI;
- Single- and multi-dish astronomy;
- Geodesy;
- Technical capabilities; and
- Global networks and synergistic platforms.

Figure 23: SARAO research infrastructure



11.4.1 ASTRONOMY CONTRIBUTION TO STRATEGIC OBJECTIVE 1: PROMOTE GLOBALLY COMPETITIVE RESEARCH AND INNOVATION

INCREASE AND PROVIDE SUPPORT FOR HUMAN CAPACITY DEVELOPMENT

The key HCD initiatives planned over the MTEF period include:

- The continuation of the HCD programme currently managed and funded by SKA SA. To date, the SKA SA Human Capital Development Programme has funded 829 university academics, postdoctoral fellows, postgraduate and undergraduate students, as well as students training to be artisans. Of this total, 148 students are from other African countries, with 106 from the African SKA partner countries;
- The creation of two additional SARCHI in the areas of pulsar research and active galactic nuclei, which will complement the two chairs awarded in 2017 – one is for SALT astronomy and the other is a joint chair to be hosted by South African and Namibian universities;
- A programme to fund research fellowships for South African students, in partnership with the universities, towards creating an academic career path for senior-level postdoctorates. In addition, there will be continued focus on increasing the number of black and women students with master's and doctoral degrees;
- A focus on accessing external funding, particularly for increasing capacity development at the universities in the SKA partner countries in Africa (Kenya, Ghana, Zambia, Mauritius, Mozambique, Madagascar, Namibia and Botswana). The objective is to obtain funding to replicate the South African pipeline-capacity development model in these countries, albeit on a smaller scale;
- The full operationalisation of the three-node National Astrophysics and Space Science Programme (NASSP) from 2018 onwards, subject to availability of funds. The other two nodes will be hosted by the University of KwaZulu-Natal and North-West University. This programme is a collaboration between several universities and four

of the National Research Facilities that allows graduates with a BSc in astronomy, physics or closely related subjects to continue with postgraduate studies to doctoral level or to enter the work environment. It will be further expanded in the future to include a node in another African country after the full commissioning of the Pan African University in Space Science, which will be hosted by South Africa. The South African host university is currently being finalised in consultations between the DST and DHET;

- Application will be made each year as required to access NRF Professional Development Programme grants to grow the number of doctorals and postdoctoral positions, especially at SARAO and SAO; and
- The astronomy cluster will continue to participate in the DST/NRF Internship Programme in which unemployed science, engineering, and technology graduates and postgraduates will be afforded an opportunity to acquire practical work experience and improve their competencies through mentoring and exposure to a research environment.

SUPPORT MULTIDISCIPLINARY RESEARCH AND INNOVATION

Over the MTEF period, multidisciplinary research will continue through the projects below.

A. SARAO

- Manufacture of the next generation of Reconfigurable Open Architecture Computing Hardware (ROACH) boards, called SKARAB. These will be used in MeerKAT, as well as being deployed and used in a number of other international facilities and organisations. It is expected that SKARAB hardware will be available commercially, through the SKA SA commercialisation programme, from 2018;
- The Real Time Analyser (RTA) is a time-domain instrument that is useful to detect radio-frequency interference (RFI) and electromagnetic compatibility. This is crucial for radio astronomy, but is also needed in most electronic-product certification.

A comprehensive market analysis and associated distribution channels study will be completed in 2017 with a view to developing a commercially available RTA;

- The Data Storage Solution (DSS) has been devised through partnership with local companies to develop and industrialise a high-capacity, high-bandwidth storage appliance to be used as part of the infrastructure for the MeerKAT radio telescope. Capacity and reduced data rate costs are the prime drivers for this device;
- Big Data is seen as the area with the largest potential for wider benefit from SA's involvement in the MeerKAT and SKA project. Excellent progress is being made in a number of areas of Big Data using SKA as a trigger. SKA SA has its own areas of Big Data development needed to support the operation of the telescopes;
- Ironhive is a low-cost, high-performance, power-efficient and ruggedised computer solution. Ultra-low-energy cooling is provided through state-of-the-art geothermal exchange. This solution is particularly suited to harsh and rural environments, as they require very little additional infrastructure as with a traditional data centre. The first prototype was complete by late 2016, with commercial production from early 2017;
- As part of ongoing projects aimed at mitigating the risk of RFI, the SKA SA intends to establish competency in the tracking of all aircraft in the Karoo area, to be achieved without the introduction of any new transmitters. One of the most promising solutions is the use of passive radar technology, also called Commensal Radar (Comrad). Recent trials to test the suitability of the system were undertaken in partnership with a local company developing the technology, and the results were positive;
- An analysis of historical maser data and new observations in order to revitalise maser research. A project to search for water (22 GHz) masers towards the southern hemisphere Herbig-Haro objects that may be viable with the new SARA0 22 GHz cooled receiver is being progressed. These projects would provide many

opportunities for multi-wavelength (multidisciplinary) studies, specifically in the optical using SAAO facilities; and

- SARA0 is part of a new international collaboration to find high-redshift AGN sources in the south using the SALT telescope and followed-up by radio VLBI observations in collaboration with NWU and international partners.

B. SAAO

The SAAO has several high-impact research activities in optical astronomy, including:

- The ongoing work in planetary astronomy, which will monitor changes in Pluto's atmosphere as it recedes from perihelion and will measure the sizes of and search for atmospheres on other Kuiper Belt Objects (KBOs). The observations of Pluto were particularly important between 2014 and 2016, in order to place data from the National Aeronautics and Space Administration (NASA) New Horizons spacecraft into context;
- Several projects are ongoing in the study of Milky Way companions. One will study their chemical evolutions, star formation histories, and structural properties using different spectral modes of SALT instrumentation. Another has been using the IRSF (the joint Japanese–South African IR telescope at Sutherland) to discover the highly evolved Asymptotic Giant Branch populations, which will then be targeted by SALT. A third is looking at slightly more distant dwarf galaxies, combining IRSF data and SALT spectroscopy to look for central black holes; and
- The cosmology group is involved in both the LADUMA and MIGHTEE large-scale surveys on MeerKAT, for which novel algorithms are being developed for cross-correlating optical and radio surveys and for transient detection where machine-learning algorithms are being tested and adapted with a view to use in the SKA.

11.4.2 ASTRONOMY CONTRIBUTION TO STRATEGIC OBJECTIVE 2: ENHANCE STRATEGIC INTERNATIONAL ENGAGEMENTS

PROMOTE SYSTEM-WIDE INTERNATIONAL ENGAGEMENT AND EXPLOIT INTERNATIONAL RESEARCH PLATFORM ACCESS

There are 45 formal international collaborations to date and this is expected to grow to at least 55 over the MTEF period. Some of the major collaborations are listed below:

- SARAO will continue its interactions with the international SKA Office with regard to the hosting agreement. Ongoing discussions will continue on SKA1_MID, and the integration of MeerKAT into this phase;
- The African partners are actively engaged in the AVN as well as in preliminary discussions on SKA through the African SKA working groups;
- In addition, collaborations on guest instruments, namely C-Band All Sky Survey (C-BASS) and HERA, will continue to grow – with HERA expected to be fully operational in 2018. SKA SA has provided active support for the development of HERA, a follow-up to the Precision Array for Probing the Epoch of Reionization (PAPER);
- The Max Planck Institute for Radio Astronomy (MPIfR) in Germany has made available approximately R150 million to build and install radio receivers on MeerKAT. The receivers will be built by the MPIfR and will operate in the S band of radio frequencies. They will be used primarily for research on pulsars;
- Plans for an Astronomy Training Platform including Joint Exchange and Development Initiative (JEDI) workshops have been finalised; wherein the focus is on astronomy-related training in the AVN partner countries. A few successful JEDI workshops have taken place, but the future plans for these high-impact interventions are largely unfunded at present. Currently, training in Ghana is funded

for three years by the Royal Society Africa Award. It is anticipated that the Newton Fund and associated South African funding will be extended to continue this successful training programme. Training topics include:

- Astrophysics: Introductory astrophysics including multi-wavelength astronomy with emphasis on radio astronomy;
- Technical training: Theory, hands-on usage and maintenance of the telescope, receiver and VLBI equipment;
- Radio observations: Single-dish and VLBI observations, survey astronomy and presentation skills; and
- Data reduction and analysis: Reduction and analysis of training data, as well as telescope time and training in doctoral application writing.



- The Sutherland observing station has strategic advantages that have, to date, attracted 11 international telescopes for astronomy and Earth system science. Principal among these is SALT, a 10-metre class optical telescope developed and funded by a consortium of international partners from South Africa, the USA, Germany, India, Poland, UK and New Zealand. South Africa is the largest single shareholder in SALT (33%). SAAO operates SALT on a contractual basis on behalf of the SALT Foundation, the entity that owns SALT;
- A contract has been signed between the International Astronomical Union (IAU) and the NRF for a further six years, commencing 1 January 2016, for SAAO to host the IAU's Office for Astronomy Development (OAD). The OAD currently coordinates nine regional offices around the world and has funded 68 projects in over 30 countries;
- In terms of inter-facility collaborations, iThemba LABS facilitated an agreement between the SAAO and CERN where the SAAO was contracted to manufacture a complete set of interconnected assembly pieces for the new small wheel assembly at CERN. These colourless organic thermoplastic polymer (Polyether Ether Ketone) components are to be inserted into the ATLAS detector cavern. ATLAS is one of two general-purpose detectors at the Large Hadron Collider (LHC) that investigates a wide range of physics, from the search for the Higgs boson to extra dimensions and particles that could make up dark matter. The manufacturing technology, and related skills development at the SAAO mechanical workshop, have the potential to yield more commissioned work for the facility. The first shipment of the machined pieces was delivered to CERN in January 2017;
- SARAO (through former facility HartRAO) has been a member of the European VLBI Network (EVN) since 2011, having been an associate member for the previous 10 years. The 26-metre telescope also operates as part of the Australia Telescope Long Baseline Array (AT-LBA) to provide a southern hemisphere astronomical VLBI platform. The facility further provides observing time to the International VLBI Service for Geodesy and Astrometry (IVS). The former facility hosted the IVS General Meeting in March 2016;
- SARAO is an important ground station for RadioAstron observations, and is also involved in two of the early science groups for the RadioAstron Space-VLBI satellite, on masers and AGN. The facility has established a working group in collaboration with Wits for the analysis of the RadioAstron data;
- SARAO continues to operate MOBILAS-6 in collaboration with NASA Goddard Space Flight Center (GSFC). Several upgrades during the past year and additional operator training at GSFC in Washington DC have improved the capacity to maintain the system locally; and
- Three international groups have expressed interest in identifying and possibly developing an astronomical site for millimetric observations. These include the Centre for Astrophysics at Harvard University (USA), ROSCOSMOS (Russia), and a group in the Netherlands. VLBI experiments at millimetre wavelengths require a facility in southern Africa; four-millimetre telescopes are required to observe the event horizon of the black hole at the centre of the Milky Way – an experiment of paramount importance in astronomy today. Criteria for site selection include a high-altitude and dry site such as the Atacama Large Millimetre Array, which is built at 5 000 metres above sea level in the world's driest desert, the Atacama. An initial comparative analysis of various southern African sites has been completed, including sites at SARAO, SKA SA, Sutherland, in Lesotho, Gamsberg (Namibia) and Mount Kilimanjaro (Tanzania). Preliminary results indicate that Lesotho is the most suited and test equipment is being installed at the preferred sites for year-long monitoring.

11.4.3 ASTRONOMY CONTRIBUTION TO STRATEGIC OBJECTIVE 4: ESTABLISH AND MAINTAIN RESEARCH AND INFRASTRUCTURE PLATFORMS

PROVIDE SCIENCE INFRASTRUCTURE IN PRIORITY AREAS

Research infrastructure requires regular renewal and enhancement.

A. SAAO

Over the MTEF period, the following initiatives will be facilitated:

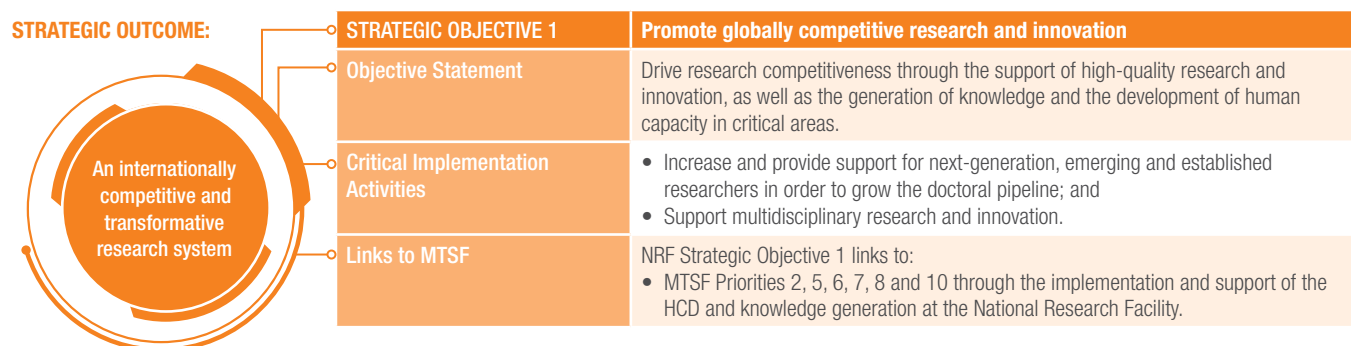
- A new, robotic 1-metre optical telescope (R17 million) was operational from the last quarter of the 2016/17 financial year and additional instruments will be developed during 2017/18;
- Through instrumentation upgrades on the 1-metre and 1,9-metre telescopes, astronomers will be able to enhance research activities so that usage of these two instruments will increase;
- Access to observing time on the international telescopes located on the Sutherland plateau will be facilitated. The SAAO and South African astronomers have access to predetermined observing time on the IRSF, LCOGT, KMTNet and MONET. SAAO manages the allocation of this observing time, which is normally fully subscribed; 15 papers were produced in 2015/16, with six being ISI publications. These instruments supported a total of 29 proposals as well as 11 postgraduate students; and
- Development of the novel Spherical Transmission Grating Spectrograph (STGS), which was designed by the late D. O'Donoghue, will be pursued. This instrument is expected to return high-throughput, low-to-medium-resolution spectra and the plan includes building a prototype of the STGS for future use on SALT, the 1,9-metre telescope, and the new 1-metre telescope.

B. SARAO

Over the MTEF period, the SARAO component will:


- Work on a new, fast-slewing, 13,2-metre, VGOS (VLBI in the Geodetic Observing System) compliant VLBI radio telescope (R49 million), with commissioning scheduled for mid-2017;
- Complete the upgrade of geodetic infrastructure to extend the current platform in new scientific areas (R10 million);
- Replace the old operating spectrometer, which is 20 years old and developing faults. The new spectrometer will be built from ROACH-1 technology, which is being used on the Ghanaian Radio Telescope – this new instrument will support maser research;
- Continue to work on the development of a 1-metre optical telescope donated to South Africa by France as part of the joint LLR project started in 2008. Projected completion is in 2017/18.
- The MeerKAT will be commissioned in a phased manner, known as array releases. The first 16 receptors along with a 16-element ROACH-2 based correlator, TFR system, CAM and SDP software make up Array Release 1, which was successfully released in June 2016. It was the first formal engineering release within MeerKAT to allow for the verification of basic interferometric performance of the telescope. It is considered the most challenging release of the whole project, as it was the first time an end-to-end system was integrated and formally verified on site. The completion date for Array Release 2 and the subsequent engineering verification base array releases are planned for 2018/19; and
- Development of the AVN in African partner countries will proceed, with at least the converted dish in Ghana being operational in 2018 and considerable progress being made for new builds in Namibia and Botswana by the end of the MTEF period.

Table 24: Astronomy and geodetic sciences – KPIs against budget (2018/19–2020/21) – Strategic Objective 1



INDICATORS	Actual 2015	Actual 2016	Actual 2017	Target 2018	Proj. 2019	Proj. 2020	Proj. 2021
Number of postgraduate students supported by the National Research Facilities	153	109	118	121	125	143	163
ISI publications by researchers at the National Research Facilities	136	136	141	164	142	159	181
Number of users of National Research Facilities	114	137	1293	1 378	1370	1655	1705
Citation impact of National Research Facility outputs (annual cumulative)	>1	2	1.32	>1.25	>1.32	>1.33	>1.33
BUDGET (R million)	Actual 2015	Actual 2016	Actual 2017	Target 2018	Proj. 2019	Proj. 2020	Proj. 2021
Globally competitive research	87,131	104,322	117,299	152,404	161,167	170,133	176,614


Table 25: Astronomy and geodetic sciences – KPIs against budget (2018/19–2020/21) – Strategic Objective 2

 <p>STRATEGIC OUTCOME:</p> <p>An internationally competitive and transformative research system</p>	STRATEGIC OBJECTIVE 2	Enhance strategic international engagements
	Objective Statement	Promote system-wide international engagement and collaboration in order to support emerging knowledge fields and provide local researchers with access to innovative research infrastructure.
	Critical Implementation Activities	<ul style="list-style-type: none"> Promote system-wide international engagement; and Facilitate international research platform access.
	Links to MTSF	NRF Strategic Objective 2 links to: <ul style="list-style-type: none"> MTSF Priorities 10 and 11

INDICATORS	Actual 2015	Actual 2016	Actual 2017	Target 2018	Proj. 2019	Proj. 2020	Proj. 2021
Number of joint international agreements at the National Research Facilities	45	45	48	47	45	48	51

BUDGET (R million)	Actual 2015	Actual 2016	Actual 2017	Target 2018	Proj. 2019	Proj. 2020	Proj. 2021
Internationalisation	76,343	153,486	456,497	270,996	178,039	304,332	301,177

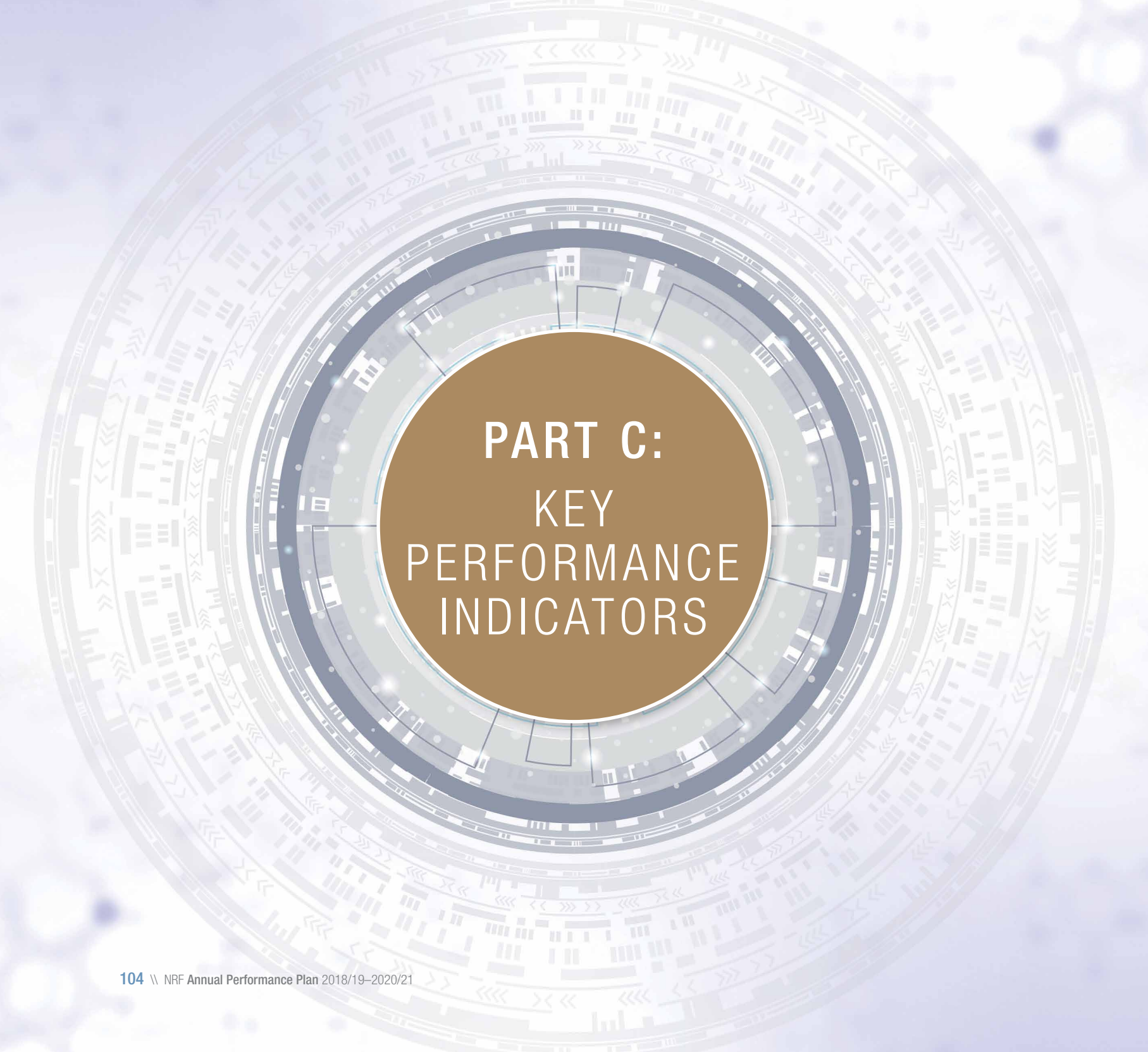
Table 26: Astronomy and geodetic sciences – KPIs against budget (2018/19–2020/21) – Strategic Objective 4

 <p>STRATEGIC OUTCOME:</p> <p>Leading-edge research and infrastructure platforms</p>	STRATEGIC OBJECTIVE 4	Establish and maintain research infrastructure and platforms
	Objective Statement	Providing and facilitating access to world-class equipment and infrastructure through the acquisition of high-end equipment and the support of National Research Facilities.
	Critical Implementation Activities	<ul style="list-style-type: none"> Provide science infrastructure in priority areas; Incubate, nurture and strategically locate research platforms; and Develop human capacity in priority research areas.
	Links to MTSF	NRF Strategic Objective 4 links to: <ul style="list-style-type: none"> MTSF Priorities 2 and 10 through the provision of research equipment and research platforms.

INDICATORS	Actual 2015	Actual 2016	Actual 2017	Target 2018	Proj. 2019	Proj. 2020	Proj. 2021
Total infrastructure investment in the National Research Facilities (R million)	215.63	372.57	625,59	581,42	315.17	81.22	73.05

BUDGET (R million)	Actual 2015	Actual 2016	Actual 2017	Target 2018	Proj. 2019	Proj. 2020	Proj. 2021
Platform and infrastructure provision	430,061	518,491	616,608	731,164	713,465	437,112	481,225

The budget includes Capex and operational/support costs.



PART C:
KEY
PERFORMANCE
INDICATORS



NRF PERFORMANCE INDICATORS

Table 27: The corporate indicators set targets for the NRF's performance against the strategic goals of the organisation. Its performance targets are structured in accordance with the strategic goals of the NRF.

INDICATORS	Actual 2014/15	Actual 2015/16	Actual 2016/17	Proj. 2017/18	Target 2018/19	2018/19 Q1	2018/19 Q2	2018/19 Q3	Proj. 2019/20	Proj. 2020/21	
OUTCOME: An internationally competitive and transformative research system											
STRATEGIC OBJECTIVE 1											
Number of NRF funded researchers from designated groups	Black	1 235	1 355	1 563	1 960	2 182	1 245	1 827	2 007	2 090	2 257
	Female	1 514	1 610	1 699	2 450	1 520	868	1 271	1 398	2 158	2 324
Number of postgraduate students funded from designated groups	Black	7 057	8 980	10 747	10 350	9 350	5 347	7 784	8 603	9 566	9 785
	Female	5 976	7 032	8 017	8 700	7 119	4 075	5 911	6 550	7 339	7 511
Number of NRF rated researchers from designated groups	Black	766	866	970	936	1 026				1 120	1 176
	Female	962	1 054	1 176	1 188	1 292				1 400	1 470
WoS publications published by the National Research Facilities		369	414	462	370	397	195	275	340	434	476
STRATEGIC OBJECTIVE 2											
Number of active grants emanating from binational, multinational as well as agency-to-agency agreements		1 055	1 275	1 008	1 404	990	495	743	990	990	990
STRATEGIC OBJECTIVE 3											
Total number of researchers rated through the NRF system		3 161	3 369	3 663	3 600	3 750				3 900	4 000

INDICATORS	Actual 2014/15	Actual 2015/16	Actual 2016/17	Proj. 2017/18	Target 2018/19	2018/19 Q1	2018/19 Q2	2018/19 Q3	Proj. 2019/20	Proj. 2020/21	
OUTCOME: Leading-edge research and infrastructure platforms											
STRATEGIC OBJECTIVE 4											
Number of users of equipment that was funded by the NEP and NNEP programmes	1 700	2 360	2 950	2 000	2 641				2 242	1 824	
Number of publications emanating from the use of equipment funded by the NEP and NNEP programmes	1 700	1 105	779	1 250	695				540	430	
OUTCOME: A reputable and influential agency shaping the science and technology system											
STRATEGIC OBJECTIVE 5											
Number of internal and external users of the NRF business intelligence systems	0	14	74	70	150	130	140	145	160	160	
STRATEGIC OBJECTIVE 6											
Unqualified audit report	yes	yes		yes	yes				yes	yes	
Corporate overheads: calculated as a percentage of total expenditure	2%	2%	1.4%	<3%	<3%				<3%	<3%	
Total overheads: calculated as a percentage of total expenditure	7.9%	5.5%	5.3%	<10%	<10%				<10%	<10%	
OUTCOME: Scientifically literate and engaged society											
STRATEGIC OBJECTIVE 7											
Approximate number of public reached through SAASTA's science awareness activities	972 547	1 013 716	1 084 760	1 080 000	1 080 000	295 000	360 000	870 000	1 090 000	1 090 000	
OUTCOME: A skilled and committed NRF research and technical workforce											
STRATEGIC OBJECTIVE 8											
Proportion of South Africans from designated groups in senior technical and managerial positions incl. SKA (Peromnes 1 - 8)	Black	250	275	287	262	275	270	273	275	282	282
	Female	179	195	198	187	192	188	190	192	198	198



PART D:
SUPPORTING
INFORMATION



ALIGNMENT TO DST STRATEGIC OUTCOMES

Table 28: Alignment to MTSF priorities and DST strategic outcomes

No	MTSF priority outcomes	Strategic outcomes	Responding NRF programme	Initiatives	DST strategic oriented goals
1	Quality basic education	4	Programme 2	13 SARCHI Chairs focusing on Mathematics; Numeracy education; Integrated studies of learning languages, mathematics and science; Teacher education; Higher education and human development; and Work-integrated learning.	Human capital development
2	A long and healthy life for all South Africans	1	Programmes 3 and 4	<ul style="list-style-type: none"> 40 SARCHI Chairs focusing on HIV vaccination translation; Detection of cardiovascular diseases; Poverty-related diseases; TB biomarkers; Malaria, etc. 3 CoEs focusing on epidemiology, HIV prevention and biomedical TB research. iThemba LABS supplies rare isotopes globally for the early detection and treatment of cancers and provides the only cancer treatment facility of its kind on the continent. 	Increased knowledge generation
		2			
3	All people in South Africa are and feel safe				
4	Decent employment through inclusive growth	3	Programme 1	The NRF adheres to fair and transparent procurement and employment practices, and subscribes to the BBBEE Act. Furthermore, the organisation supports the DST/NRF Internship Programme by training and, where possible, retaining interns in various fields. The professional development programme supports doctoral graduates' transition into positions within the business, while the management development programmes support staff in becoming better managers within the NRF.	
		5			
5	A skilled and capable workforce to support an inclusive growth path	1	Programme 3	In order to ensure that the organisation continues to create and support a skilled and capable workforce, the NRF provides support for postgraduate studies, assists researcher development at the HEIs (including the provision of targeted grants for this purpose), and supports staff internal to the NRF.	Increased knowledge generation
		5	Programmes 1 and 4		
6	An efficient, competitive and responsive economic infrastructure network	1	Programme 3	<p>The NRF funds research on renewable energy solutions through:</p> <ul style="list-style-type: none"> The Energy Capacity Development and Knowledge Generation (EHCD&KG) programme and the Energy Research Programme (ERP); iThemba LABS provides nuclear research infrastructure. <p>The NRF also provides world-class research infrastructure in various science domains.</p>	Increased knowledge generation

No	MTSF priority outcomes	Strategic outcomes	Responding NRF programme	Initiatives	DST strategic oriented goals
7	Vibrant, equitable and sustainable rural communities contributing towards food security for all	1	Programmes 3 and 4	<ul style="list-style-type: none"> 2 UK-SA SARChI bilateral chairs focusing on food security; 2 SARChI chairs focusing on systems biology for food security and phytochemical food networks from a nutrition perspective; 1 CoE focusing on sustainable food systems to realise food security for poor, vulnerable, and marginal populations. 	Increased knowledge generation
8	Sustainable human settlements and improved quality of household life	1	Programmes 3 and 4	The NRF is currently creating a community of practice around human settlements.	Increased knowledge generation
9	Responsive, accountable, effective and efficient local government				
10	Protect and enhance our environmental assets and natural resources	1	Programmes 3 and 4	<ul style="list-style-type: none"> 30 SARChI chairs focusing on environmental research in areas such as agricultural sciences; agro-chemistry; evolution biology; as well as climate change; Earth system science; marine ecosystems and palaeo-environmental studies. 3 CoEs in biodiversity, conservation, and biotechnology. The National Research Facilities, through SAEON and SAIAB, have contributed to national policy development around the protection of environmental assets. 	Responsive, coordinated and efficient NSI
		2			Increased knowledge generation
11	Create a better South Africa and contribute to a better Africa and a better world	3	Programme 1	The NRF builds on its brand and reputation to foster international research partnerships and scientific collaboration on the African continent and globally, thus playing a role in creating a better South Africa and Africa.	Responsive, coordinated and efficient NSI
		1	Programmes 3 and 4		
12	An efficient, effective and development-oriented public service				
13	A comprehensive, responsive and sustainable social protection system				
14	A diverse, socially cohesive society with a common national identity	4	Programme 2	The NRF contributes through the effective generation, communication and dissemination of knowledge to society. To this end, the NRF has created 2 SARChI chairs in science communication.	Human capital development
		3	Programme 1		



PART E:
POLICY
FRAMEWORK



NRF SUPPORTING POLICY FRAMEWORK

14.1 THE NRF SUPPORTING POLICY FRAMEWORK

Table 29: The NRF Supporting Policy Framework

	SUPPORTING FRAMEWORK
A	Exemptions granted from the provisions of the PFMA
B	Risk Management Plan
C	Fraud Prevention Plan
D	Materiality and Significance Framework
E	Schedule of the NRF Board's main activities
F	Structure and composition of the NRF Board and its committees
G	Employment Equity Plan
H	Business Development Strategy
I	Communication Plan
J	ICT Plans

Policies that form the supporting framework of the operations of the NRF are available on request.



14.2 APPLICABLE SUSTAINABILITY BEST-PRACTICE CODES AND STANDARDS

Where applicable, the business units subscribe to best-practice codes and standards. SKA SA is in the process of becoming fully ISO 9001 compliant.

Table 30: Applicable sustainability best-practice codes and standards

Best-practice codes and standards		RISA	SAEON	SAASTA	SAIAB	SARAO	SAAO	iThemba LABS	SKA
1	King III Code of Corporate Governance for SA	●	●	●	●	●	●	●	●
2	International Financial Reporting Standards (IFRS) for Financial Reporting	●	●	●	●	●	●	●	●
3	ISO 14001:2004 Environmental Management System		●		●			●	●
4	ISO 9001:2008 Quality Management System	●		●	●			●	
5	Current Good Manufacturing Practices (cGMP)							●	
6	International Atomic Energy Agency (AEA) standards							●	

14.3 CODES, STANDARDS AND LEGISLATION APPLICABLE TO HR AND LEGAL SERVICES

Table 31: Codes, standards and legislation applicable to HR and Legal Services

Codes, standards and legislation applicable to HR and Legal Services	
The Constitution of the Republic of South Africa (Act No. 108 of 1996)	The Compensation for Occupational Injuries and Diseases Act (No. 130 of 1993)
The Labour Relations Act (No. 66 of 1995)	The Pension Fund Act (No. 24 of 1956)
The Basic Conditions of Employment Act (No. 75 of 1997)	The Medical Schemes Act (No. 131 of 1998)
Code of Good Practice on Dismissals	The Income Tax Act (No. 58 of 1962)
Employment Equity Code of Good Practice	The Skills Development Act (No. 97 of 1998)
The National Research Foundation Act (No. 23 of 1998)	The Skills Development Levies Act (No. 9 of 1999)
The Occupational Health and Safety Act (No. 85 of 1993)	The South African Qualifications Authority Act (No. 58 of 1995)
The Employment Equity Act (No. 55 of 1998)	The Promotion of Equality and Prevention of Unfair Discrimination Act (No. 4 of 2000)
The Broad-Based Black Economic Empowerment Act (No. 53 of 2003)	The Promotion of Access to Information Act (No. 2 of 2000)
The Unemployment Insurance Act (No. 63 of 2001)	The Promotion of Administration Justice Act (No. 3 of 2000)
The Protection of Personal Information Act (Act No. 4 of 2013)	

Table 28: Priority compliance listing of applicable legislation and best practice

Legislation		RISA	SAEON	SAASTA	SAIAB	SARAO	SAAO	iThemba LABS	SKA
1	National Research Foundation Act 23 of 1998	●	●	●	●	●	●	●	●
2	Occupational Health and Safety Act 85 of 1993	●	●	●	●	●	●	●	●
3	National Water Act 36 of 1998	●	●	●	●	●	●	●	●
4	NEMA - National Environmental Management Act 107 of 1998	●	●	●	●	●	●	●	●
5	Public Finance Management (PFMA) Act 1 of 1999	●	●	●	●	●	●	●	●
6	New Companies Act 71 of 2008	●	●	●	●	●	●	●	●
7	Intellectual Property Rights from Publicly Financed Research and Development Act 51 of 2008	●	●	●	●	●	●	●	●
8	Skills Development Act 97 of 1998	●	●	●	●	●	●	●	●
9	Employment Equity Act 55 of 1998	●	●	●	●	●	●	●	●
10	Labour Relations Act 66 of 1995	●	●	●	●	●	●	●	●
11	Basic Conditions of Employment Act 75 of 1997	●	●	●	●	●	●	●	●
12	National Environmental Management: Biodiversity Act 10 of 2004		●		●				
13	National Environmental Management: Biodiversity Act, 2004 (Act 10 of 2004): Threatened or Protected Species Regulations		●		●				
14	Astronomy Geographic Advantage Act 21 of 2007					●	●		●
15	Mine Health and Safety Act 29 of 1996								●
16	Mineral and Petroleum Resources Development Act 28 of 2002								●
17	Marine Living Resources Act 18 of 1998				●				
18	National Environmental Management: Air Quality Act (NEM:AQA), 39 of 2004							●	
19	National Environmental Management: Waste Act 59 of 2008				●			●	●
20	Promotion of Access to Information Act 2 of 2000	●	●	●	●	●	●	●	●
21	Occupational Health and Safety Act 85 of 1993: Diving Regulations				●				
22	Occupational Health and Safety Act 85 of 1993: Construction Regulations								●
23	National Radioactive Waste Disposal Institute Act 53 of 2008							●	
24	National Health Act 61 of 2003							●	
25	South African National Space Agency Bill (B20 of 2008)					●	●		●
26	Compensation for Occupational Injuries and Diseases Act 130 of 1993								
27	Animal Protection Act 71 of 1962		●						

PART F: KEY CONTACT DETAILS

15 CONTACTS

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PART G: ACRONYMS



LIST OF ACRONYMS

ACCESS	Applied Centre for Climate and Earth Systems Science
ACE Beams	Accelerator Centre for Exotic Beams
ACE Isotopes	Accelerator Centre for Exotic Isotopes
ACEP	African Coelacanth Ecosystem Programme
ADR	Alternative Dispute Resolution
AEA	(International) Atomic Energy Agency
AERP	Aquatic Ecophysiology Research Platform
AGN	Active Galactic Nucleus
AGRP	Aquatic Genomics Research Platform
ALBA	African LaBr3 array
AMS	Accelerator mass spectrometry
APP	Annual Performance Plan
ARC	Agricultural Research Council
ATAP	Acoustic Tracking Array Platform
AT-LBA	Australia Telescope Long Baseline Array
AU	African Union
AVN	African Very Long Baseline Interferometry (VLBI) Network
BAC	Bid Award Committee
BBBEE	Broad-Based Black Economic Empowerment
C-BASS	C-Band All Sky Survey
CBTBR	Centre of Excellence in Biomedical TB Research
CCMA	Commission for Conciliation, Mediation and Arbitration
CEO	Chief executive officer
CERN	European Organization for Nuclear Research (Organisation Européenne pour la Recherche Nucléaire)
cGMP	Current Good Manufacturing Practices
CHE	Council on Higher Education
CIB	Centre of Excellence for Invasion Biology
CIKS	Centre in Indigenous Knowledge Systems

CIMERA	Centre of Excellence for Integrated Mineral and Energy Resource Analysis
CoDATA	Committee on Data for Science and Technology
CoE	Centre of Excellence
CoP	Committee of Plenipotentiaries
CoP	Community of Practice
CPI	Consumer price index
CPRR	Competitive Programme for Rated Researchers
CPUT	Cape Peninsula University of Technology
CRTS	Catalina Real-Time Transient Survey
CSD	Central Supplier Database
CSIR	Council for Scientific and Industrial Research
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CSUR	Competitive Support for Unrated Researchers
CTHB	Centre of Excellence in Tree Health Biotechnology
DAFF	Department of Agriculture, Forestry and Fisheries
DEA	Department of Environmental Affairs
DHET	Department of Higher Education and Training
DNA	Deoxyribonucleic acid
DoHS	Department of Human Settlements
DOI	Digital object identification
DPSIR	Drivers, pressures, state, impacts and responses
DSAM	Doppler shift attenuation method
DSS	Data Storage Solution
DST	Department of Science and Technology
DWS	Department of Water and Sanitation
EHCD&KG	Energy Human Capacity Development and Knowledge Generation
ERC	European Research Council
ERM	Enterprise risk management
ERP	Energy Research Programme
ESRF	European Synchrotron Radiation Facility
ETFEON	Expanded Terrestrial and Freshwater Environmental Observation Network
EU	European Union
EVN	European VLBI Network
FAIR	Findable, accessible, interoperable, and re-usable (data)
FRF	First Rand Foundation
FSATI	French South African Institute of Technology
GCRP	Global Change Research Plan
GDP	Gross domestic product

GEO	Group on Earth Observation
GEOSS	Group on Earth Observation System of Systems
GERD	Gross expenditure in R&D
GMSA	Grants Management and Systems Administration
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
GSFC	Goddard Space Flight Center
HartRAO	Hartebeesthoek Radio Astronomy Observatory
HBU	Historically black university
HCD	Human capacity development
HDI	Historically disadvantaged institutions
HEI	Higher education institution
HERA	Hydrogen Epoch of Reionization Array
HICD	Human and Infrastructure Capacity Development
HIV	Human immunodeficiency virus
HR	Human resources
HRDS	Human Resource Development Strategy
IAU	International Astronomical Union
ICSU	International Council for Science
ICT	Information and communication technology
IFRS	International Financial Reporting Standards
IKS	Indigenous knowledge systems
ILTER	International Long-Term Ecological Research Network
INSTN	French National Institute for Nuclear Science and Technology
IPAP	Industrial Policy Action Plan
IRSF	InfraRed Survey Facility
ISI	International Scientific Indexing
ISOLDE	On-Line Isotope Mass Separator
IT	Information technology
iThemba LABS	iThemba Laboratory for Accelerator Based Sciences
IVS	International VLBI Service (for Geodesy and Astrometry)
JEDI	Joint Exchange and Development Initiative
JINR	Joint Institute for Nuclear Research
KAS	Knowledge Advancement and Support
KAT	Karoo Array Telescope
KBO	Kuiper Belt Object
KIC	Knowledge Interchange Collaboration
KM	Knowledge management

KPI	Key performance indicator
KZN	KwaZulu-Natal
LERIB	Low Energy Rare Ion Beam
LHC	Large Hadron Collider
LLR	Lunar laser ranger
LSST	Large Synoptic Survey Telescope
LTER	Long Term Ecological Research
M&E	Monitoring and Evaluation
MANuS	Masters in Accelerator and Nuclear Science
mar-RIP	Marine Remote Imagery Platform
MARS	Marine and Antarctic Research Strategy
MaSS	Centre of Excellence in Mathematical and Statistical Sciences
MatSci	Master's in Materials Science
MCM	Marine and Coastal Management
MDDA	Media Development and Diversity Agency
MDP	Management Development Programme
MP	Member of parliament
MPA	Marine protected area
MPIfR	Max Planck Institute for Radio Astronomy
MTEF	Medium-Term Expenditure Framework
MTSF	Medium-Term Strategic Framework
MV	megavolt
NACI	National Advisory Council on Innovation
NASA	National Aeronautics and Space Administration
NASSP	National Astrophysics and Space Science Programme
NDP	National Development Plan
NEMA	National Environmental Management Act
NEP	National Equipment Programme
NF	National Facilities
nGAP	New Generation Academics Programme
NGO	Non-governmental organisation
NICIS	National Integrated Cyberinfrastructure
NINA	Norwegian Institute for Nature Research
NIThEP	National Institute for Theoretical Physics
NNEP	National Nanotechnology Equipment Programme
NRDS	National Research and Development Strategy
NRF	National Research Foundation
NRIP	National Research Infrastructure Platforms

NSCF	Natural Science Collections Facility
NSFAS	National Student Financial Aid Scheme
NSI	National System of Innovation
NTeMBI	Nuclear Technologies in Medicine and Biosciences Initiative
NWU	North-West University
NZG	National Zoological Gardens
OAD	Office for Astronomy Development
OTN	Ocean Tracking Network
PAPER	Precision Array for Probing the Epoch of Reionization
PDP	Professional development programme
PFMA	Public Finance Management Act
PhD	Doctor of Philosophy
PPC	Parliamentary Portfolio Committee
R&D	Research and development
RCCE	Research Chairs and Centres of Excellence
RE	Reviews and Evaluation
RF	radio frequency
RFI	Radio-frequency interference
RI	Research Infrastructure
RISA	Research and Innovation Support and Advancement
ROACH	Reconfigurable Open Architecture Computing Hardware
ROV	Remotely operated underwater vehicle
RRI	Responsible research and innovation
RTA	Real Time Analyser
RV	Research vessel
S&T	Science and technology
SA	South Africa
SAAO	South African Astronomical Observatory
SAASTA	South African Agency for Science and Technology Advancement
SACEMA	South African Centre for Epidemiological Modelling and Analysis
SAEON	South African Environmental Observation Network
SAEOS	South African Earth Observation Strategy
SAGEO	South African chapter of the Group on Earth Observation
SAIAB	South African Institute for Aquatic Biodiversity
SAINTS	South African Institute of Nuclear Technology and Science
SALT	Southern African Large Telescope
SANBI	South African National Biodiversity Institute
SANCOOP	South Africa–Norway Research Cooperation on Climate Change

SARAO	South African Radio Astronomy Observatory
SARChI	South African Research Chairs Initiative
SARIR	South African Research Infrastructure Roadmap
SciSTIP	Centre of Excellence in Scientometrics and Science, Technology and Innovation Policy
SCM	Supply chain management
SDGs	Sustainability development goals
SET	Science, engineering and technology
SETI	Science, engineering, technology, and innovation
SKA	Square Kilometre Array
SMCRI	Shallow Marine and Coastal Research Infrastructure
SOSF	Save Our Seas Foundation
SPP	Strategy, Planning and Partnerships
SREP	Strategic Research Equipment Programme
SRIG	Strategic Research Infrastructure Grant
SSC	Separated sector cyclotron
STEMI	Science, technology, engineering and innovation
STGS	Spherical Transmission Grating Spectrograph
STISA	Science, Technology and Innovation Strategy for Africa
TB	Tuberculosis
the dti	Department of Trade and Industry
TYIP	Ten-Year Innovation Plan
UCT	University of Cape Town
UFS	University of the Free State
UK	United Kingdom
UKZN	University of KwaZulu-Natal
UN	United Nations
UniZulu	University of Zululand
USA	United States of America
UWC	University of the Western Cape
VGOS	VLBI in the Geodetic Observing System
VLBI	Very Long Baseline Interferometry
Wits	University of the Witwatersrand
WRC	Water Research Commission



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