ERAWATCH COUNTRY REPORTS 2010: South Africa

ERAWATCH Network – Institute for Economic Research on Innovation (IERI)

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Acknowledgements and further information:

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Executive Summary

South Africa has the largest economy in Africa. With nearly 50 million inhabitants, it accounts for only 6% of the total population in the continent but generates over 30% of the African total GDP. Despite its large representation in the African continent, the country is still comparatively small among the five BRICS countries, accounting for 3% of this group's GDP and just under 3% of its population (World Bank, 2011).

South Africa is a middle income country with a relatively established national research and innovation system. In 2008/09 the GERD reached €2.1b (21b Rands), the equivalent to 0.92% of the Gross Domestic Product (GDP). However, the consistent increase in R&D expenditures over the past decade has not been sufficient to achieve the target of 1% of GDP that was sought for 2008. The Government is the main funder of R&D (funding 45.7% of the GERD), while most of the R&D is performed by the private sector (performing almost 60% of the total R&D expenditures). Concerted efforts to promote S&T cooperation with the EU, have led South Africa to be one of the most active Third Country participants of the Framework Programmes. With over 200 participations in FP7 and a direct EC investment more than €25 million, South Africa ranks only behind USA, Russia, China and India.

The end of apartheid in 1994 marked a new era for South Africa's S&T policies, which were redefined within a national innovation system (NIS) approach. The system is currently populated by a growing number of public institutions, advisory bodies and funding agencies, guided by multiple strategies and policies that steer R&D and innovation activities. Current policies build up on the initial White Paper on Science and Technology (1996) and the subsequent National Research and Development Strategy (NRDS) (2002). The NRDS gave priority to a few technology platforms in key sectors (such as biotechnology, ICT, advanced manufacturing, and astronomy) as well as poverty alleviation. Recent policies, such as the Ten-Year Innovation Plan normatively aim at the static 3% hi-tech sector, while other sectors with larger socio-economic impact and larger job-generating potential are getting relatively less attention and research funding. These include the low-tech and medium-tech sectors to support manufacturing, the construction sector and the services sector.

South Africa's socio-economic landscape, historically shaped by inequality, continues to prove to be resilient to policy efforts at redressing it. Inequality has race, class, gender and geographic dimensions. Policy and institutional choices over the past fifteen years have skewed the research and innovation system towards largely benefiting the middle and upper income components of the economy and society.

Knowledge Triangle

In relation to the policy mix, a number of policies and programmes are in place to enhance the development of the research system, and in particular innovation has received growing attention both in policy and institutionally. However, the role of education policy in tackling the severe deficit of human resources should receive the highest priority. Achieving the 'grand challenges' or targets as established in the Ten-Year Innovation Plan, will require a significant expansion in the provision of high-level skills. South Africa's severe shortage of research skills in key areas is likely to jeopardise the achievement of the ambitious plans set up for 2018, and also exposes the weak past coordination between education, research and innovation policies. However, coordination is expected to increase with the Technology Innovation Agency (TIA), established in 2009 to improve the country's capacity to translate a greater proportion of local research and development into commercial technology products and services, bringing the knowledge from universities and public research institutions closer to industry.

	Recent policy changes	**Assessment of strengths and weaknesses**
Research policy	• NRDS operationalised in 2002. NSI approach to increase innovation for growth and development nationally. • Research Information Management System (RIMS) in 2008	• BERD is strong component of GERD. International niche leadership and significant diversity of capabilities, but relative stagnation over recent years. • Poor monitoring and evaluation of research inputs, outputs, processes and impact.
Innovation policy	• Ten-Year Innovation Plan launched in 2008 to guide transition toward a knowledge-based economy. • National Industrial Policy Framework (NIPF) adopted by Cabinet in 2007, containing Innovation and Technology Strategic Programme as necessary condition for industrialisation.	• Broad political support for innovation-led development and growth. However, there appears to be alignment challenges with extant innovation system. • Remaining focus on a few technology areas (high-tech) • Shortage of HRST likely to hinder the achievement of the 2018 targets set up in the Ten-Year Innovation Plan.
Education policy	• National Department of Education split into Department of Basic Education and Department of Higher Education and Training in 2009.	• There are critical challenges to human capital development that are major constraints to South Africa's significantly increasing its innovation led growth.
Other policies	• Gauteng Innovation Strategy adopted in 2010 important regional innovation policy.	• Innovation is heavily concentrated geographically, creating critical clustering benefits, but also severely constraining the geography of innovation.

European Research Area

Assessment of the national policies/measures which correspond to ERA objectives[1]

	ERA objectives	**Main policy changes**	**Assessment of national strengths and weaknesses**
1	Ensure an adequate supply of human resources for research and an open, attractive and competitive labour market for male and female researchers	• The Department of Education split between higher education/training and basic education in 2009. • Mobility of researchers and	• Supply of SET human capital a severe constraint to increasing R&D system • Reward for skilled SET individuals is great, but premium makes

[1] Of course non-ERA countries do not strive to achieve ERA objectives. This part of the report is simply to allow a comparison with the activities of ERA countries on these issues

	ERA objectives	Main policy changes	Assessment of national strengths and weaknesses
		research collaboration through ESASTAP • Human Resource Development Strategy for South Africa (HRD-SA) 2010 – 2030	retention in R&D system difficult
2	Increase public support for research	• Increasing target of R&D within 10-Year Innovation Plan from 1% of GDP, to 1.5% by 2014 and to 2% by 2018.	• Relative share of public GERD declining • Need to systematically increase public support and coordination identified and being addressed through range of policy instruments
3	Increase coordination and integration of research funding	• Establishment of the Technology Innovation Agency (TIA) in 2009 to support R&D investment targets and associated commercialisation of outputs	• Developing institutional capacity to translate local R&D outcomes to commercial products • Significant challenges remain around inter-departmental coordination.
4	Enhance research capacity	• Overseas/bilateral Cooperation implementing new international cooperation strategy to align international relationships with both the Ten-Year Innovation Plan and NRDS since 2009.	• Leadership in partnerships across region and the continent through SADC, the AU, and NEPAD • Difficult to unify and coordinate disparate capacity of partners
5	Develop world-class research infrastructures (including e-infrastructures) and ensure access to them	• Initiated national strategic infrastructure programme in 2010 identifying 5 critical areas for investment through MTEF	• Rising investment in RI that is aligned to broader policy goals and targets • Accessibility often limited owing to barriers of scale and historic inequities, but transformation is slow
6	Strengthen research institutions, including notably universities	• The 2001 National Plan for Higher Education restructured institutional structure of HEIs	• Numerous funding mechanisms available to HEIs and explicit incentives for research outputs • Research and supervisory capacity of research institutions, especially HEIs, constrained by limited HCD of those institutions
7	Improve framework conditions for private investment in R&D	• R&D Tax incentives scheme of 2006 and 2009 venture capital tax incentive	• Private investment in R&D robust given level of development, but dynamism of that investment not clear despite policy incentives
8	Promote public-private cooperation and knowledge transfer	• IPR Act of 2008 adopted to enhance commercialisation of publicly funded IP and establishment of TTOs	• Growing variety of programmes to facilitate knowledge circulation and transfer • Restrictions on application of collaborative IP from new IPR Act may constrain partnerships
9	Enhance knowledge circulation	• DST overseas/bilateral cooperation programme implementing since 2009 realignment strategy to	• Large and diverse cooperative agreements across the continent with considered targeted results • Different levels of development

	ERA objectives	Main policy changes	Assessment of national strengths and weaknesses
		support 10-Year Innovation Strategy and NRDS	and constraints on mobility impede potential benefits
10	Strengthen international cooperation in science and technology	• ESASTAP established under FP6 to enhance cooperation with the EU in S&T	• Significant and well established partnerships with EU • Numerous bilateral agreements with third countries, particularly within the SADC region.
11	Jointly design and coordinate policies across policy levels and policy areas, notably within the knowledge triangle	• Established Department of Performance Monitoring and Evaluation in 2010 to oversee and enhance impact of government across policy domains and departmental lines	• Development of integrated cross-departmental coordination evolving, still remain silos that need transformation • Several agencies tasked with ensuring S&T policies, but their impacts not broad-based
12	Develop and sustain excellence and overall quality of research	• Establishment of TIA in 2009 to support R&D investment targets and associated commercialisation of outputs	• Significant but relatively flat performance in knowledge outputs a recognised challenge for policy
13	Promote structural change and specialisation towards a more knowledge - intensive economy	• Ten-Year Innovation Plan launched in 2008 to guide transition toward a knowledge-based economy.	• South Africa's 'grand challenges' provide a road map for development, but unlocking skills constraint remains looming question
14	Mobilise research to address major societal challenges and contribute to sustainable development	• Ten-Year Innovation Plan launched in 2008 to guide transition toward a knowledge-based economy.	• Inequality remains challenge for sustainable development, the multi-dimensional manifestation of which has transformed slowly since liberation in 1994.
15	Build mutual trust between science and society and strengthen scientific evidence for policy making	• South African Agency for Science and Technology Advancement (SAASTA) established in 2002 within NRF to promote communication of science to the general public.	• Several field specific communication initiatives focused on promoting public understanding of science, like biotechnology, nanotechnology, hydrogen fuel cells. • Difficulties remain in conveying some messages regarding science owing to HCD challenges

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1 Introduction

The main objective of the ERAWATCH International Analytical Country Reports 2010 is to characterise and assess the evolution of the national policy mixes for the non-EU countries in the perspective of the Lisbon goals and of the 2020 post-Lisbon Strategy, even though they do not pursue these policies themselves. The assessment will focus on the national R&D investments targets, the efficiency and effectiveness of national policies and investments into R&D, the articulation between research, education and innovation. In doing this, the 15 objectives of the ERA 2020 are articulated.

Given the latest developments, the 2010 Country Report has a stronger focus on the link between research and innovation, reflecting the increased focus of innovation in the policy agenda. The report is not aimed to cover innovation per se, but rather the 'interlinkage' between research and innovation, in terms of their wider governance and policy mix.

2 Performance of the national research and innovation system and assessment of recent policy changes

The aim of this chapter is to assess the performance of the national research system, the 'interlinkages' between research and innovation systems, in terms of their wider governance and policy as well as the most recent changes that have occurred in national policy mixes in the perspective of the Lisbon goals. Each section identifies the main societal challenges addressed by the national research and innovation system and assesses the policy measures that address these challenges. The relevant objectives derived from ERA 2020 Vision are articulated in the assessment for comparison reasons.

2.1 Structure of the national research and innovation system and its governance

This section gives the main characteristics of the structure of the national research and innovation systems, in terms of their wider governance.

Main actors and institutions in research governance

South Africa has the largest economy in Africa. With nearly 50 million inhabitants, it accounts for only 6% of the total population in the continent but generates over 30% of the African total GDP. At the national level, South Africa is a middle income country (US$10,500 GDP per capita PPP in 2010) with a relatively competitive[2] and sophisticated economy[3] that has been on a sustained path of economic growth since the mid 1990s until it dropped in 2008, reaching negative growth rates in 2009 mainly due to the global economic downturn. Despite its large representation in the African continent, South Africa is still comparatively small among the five BRICS countries, accounting for 3% of this group's GDP and just under 3% of its population (World Bank, 2011).

South Africa has an established national research and innovation system. In 2008/09 the GERD reached €2.1b (21b Rands), the equivalent to 0.92% of the Gross Domestic Product (GDP) (HSRC, 2010). The consistent increase in R&D expenditures over the past decade has not been sufficient to achieve the target of 1% of GDP sought for 2008. In comparative terms, South Africa's R&D intensity is higher than India's (with an estimated GERD as % of GDP of 0.88% in 2007) but

[2] The World Economic Forum's 2010-2011 Global Competitiveness Index rated South Africa as the most competitive economy in Sub-Saharan Africa, at similar levels to Italy, Portugal and India, and above other comparable developing economies such as Brazil, Russia and Mexico; indicators available at /www.weforum.org.

[3] South Africa represented 76% of Africa's technology intensive exports in 2010 (World Bank, 2011).

slightly below the levels of the other BRICS countries (Brazil 1.08% and China 1.47% in 2008; and Russia, 1.04% in 2009) (UIS, 2010). Government and industry are the main funders of R&D in South Africa (funding 45.7% and 42.7% of the GERD respectively). However, most of the R&D is performed by the private sector (almost 60%); followed by government research institutes (including the science councils) and the higher education sector with 20% respectively (HSRC, 2010).

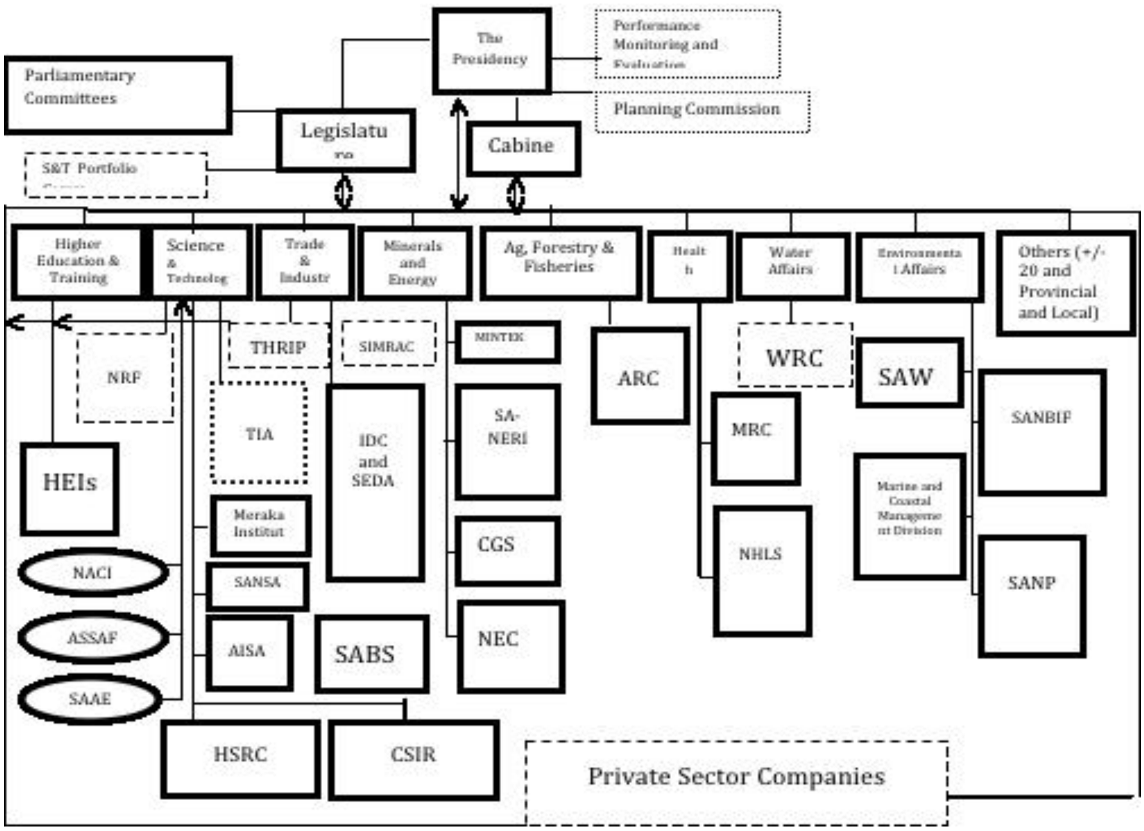
One of South Africa's more distinct historical legacies is the persistence of extreme inequality that manifests in a dual economy, where a highly-developed financial and industrial economy coexists with the large segment of poor rural and urban population living in the informal economy (this latter employs 52% of the labour force, Statistics SA, 2010). Since South Africa's liberation in 1994, the country's agenda for modernisation and socio-economic progress has recognised the importance of research, technology and innovation as key areas of policy. As a result, the last fifteen years have seen a major transformation and revision of South Africa's science and technology policy resulting in a broad array of institutions engaged in the support, funding and performance of research, innovation and technological advance.

At the highest level of policy and legislation, the key actor is Parliament (which legislates on all policy matters and budgets) and is advised by the Portfolio Committee on Science and Technology. Accountability is overseen by the Presidency (which appoints cabinet ministers) and is assisted by the National Planning Commission and the Department of Performance Monitoring and Evaluation, which provide oversight for all policy. The Department of Science and Technology (DST) is responsible for the formulation of policies related to science, technology and innovation and has also direct responsibility of overseeing the coordination, resourcing and management of public STI institutions. However, other ministries such as the Department of Trade and Industry (DTI) and the Department of Higher Education and Training (DHET) are also key players regarding policies and programmes that affect research and innovation. In addition, numerous other ministries have public sector research and innovation performers and agencies under their respective portfolios such as The Department of Minerals and Energy, The Department Agriculture, Forestry and Fisheries, the Department of Environmental Affairs, The Department of Health, the Department of Water Affairs. The Council on Higher Education and the National Advisory Council on Innovation (NACI) are mandated to advise government on policy issues that pertain to research and innovation. The Council on Higher Education (CHE) advises the Minister of Higher Education. DST is advised both by the National Advisory Council on Innovation (NACI) and a group of stakeholders represented in the National Science and Technology Forum (NSTF). The advisory role of other independent bodies such as the Academy of Science of South Africa (ASSAF) and the recently established South African Academy of Engineering (SAAE) (2007) has been rather limited (OECD, 2007).

The public funding function is mainly executed by the National Research Foundation, the Medical Research Council and the recently established Technology Innovation Agency (TIA); other relevant research funders include Water Research Commission, the South African National Energy Research Institute, and the Medical Research Council. Finally, the performance of research and innovation is spread across 23 universities, 12 public research institutions (or science councils), several museums and government departments with research capacities, the business sector and the NGO sector.

The adoption of a new Strategic Framework in 2004 by Cabinet, redefined the role of the DST assigning it the role of developing key, cutting-edge emerging areas of science and technology, leaving 'mature' areas of technology as the responsibility of their respective line departments. Before the adoption of the framework, the DST was responsible for funding all science councils, but since 2006 the DST only funds five. Funding for the other science councils comes from the line departments to which they report.

Figure 1: Overview of the South Africa's research system governance structure



South Africa's research and innovation system has formalised and expanded rapidly over the last decade. The governance system is populated by a growing number of public institutions, advisory bodies and funding agencies, along with a set of strategies and policies that steer R&D and innovation activities. However, it has been often noted that advances in policy formulation and government commitment have not been matched by their implementation (NACI, 2003; OECD, 2007). An OECD review (OECD, 2007) pointed out that some of the most pronounced remaining deficiencies include: (i) the lack of a single high-level horizontal coordinator of research and innovation policy across sectors; (ii) the weak emphasis on 'low-tech' innovation programmes for poverty reduction and the exploitation of South Africa's strong position in 'mature' industries.

The institutional role of regions in research governance

South Africa is a republic divided into nine provinces. Structurally, each of these provinces has the same authority and responsibilities. There is not an explicit role for research policy that regional governments are responsible for; however, each province implements economic development initiatives that attract investment and potential research. Consequently, research activity has been influenced through intra-regional cluster initiatives such as the Cape IT Initiative (Western Cape) – an initiative to support the ICT cluster in the Western Cape – and Blue IQ (Gauteng), which invests in and commercialises infrastructure projects in four strategic sectors: business tourism, high value-added manufacturing (high value-add), logistics and ICTs. In addition, innovation strategies at the level of the province have also been developed, such as the Gauteng Innovation Strategy.

R&D competences are highly concentrated in the two industrial provinces: Gauteng and the Western Cape. Nearly three quarters of all BERD in 2008 occurred in these two provinces – with Gauteng alone accounting for 57% of all BERD nationally (DST, 2009). These two provinces also host the majority of the research producing universities, accounting for two thirds of the total HERD. This clustering of R&D activity may play a part in the stagnation of the contribution of R&D to the local economies outside of the industrial provinces (Abrahams and Pogue, 2010).

Table 1: R&D expenditure by region 2007/2008

Province	Regional GERD as a % of Regional GDP	Regional BERD as a % of Regional GDP	Share of total GERD	Share of total BERD	Share of total HERD
Gauteng	1.41%	0.90%	51.7	57.2	34.8
Western Cape	1.24%	0.60%	19.6	16.3	28.8
Free State	1.01%	0.72%	5.9	7.3	5.0
KwaZulu-Natal	0.64%	0.40%	11.2	12.1	12.7
Eastern Cape	0.54%	0.19%	4..4	2.6	7.6
Northern Cape	0.37%	0.02%	0.9	0.1	1.3
North-West	0.35%	0.15%	2.4	1.8	4.6
Mpumalanga	0.32%	0.14%	2.4	1.8	2.9
Limpopo	0.19%	0.05%	1.4	0.7	2.2

Source: *National Survey of Experimental Research and Development 2007/08, DST 2009*

Main research performer groups

Gross domestic expenditure on R&D (GERD) in 2008 amounted to €2.1b (current prices). The key actors that perform R&D in South Africa are the business sector, the public research institutes and the universities, as well as international R&D collaborative activities. Business enterprises are the dominant actor as shown in Table 2 below. The business sector funded 43% of R&D activities – a large share for a medium-income country and comparable to more advanced economies such as Spain, Canada and the UK (OECD, 2010). BERD amounted to €1,2b, nearly 60% of the total R&D expenditures and 0.54% of the GDP. Business R&D is mainly performed by large firms (72% of BERD) such as multinationals and State corporations like Denel, Eskom, Transnet, and the recently privatised Sasol.

The business sector is followed in R&D performance by public research organisations, including science councils (20%) – some of the most important include: Africa Institute of South Africa, Agricultural Research Council, Council for Scientific and Industrial Research, Council for Geosciences, Human Sciences Research Council, Medical Research Council, Mintek, National Research Foundation and South African Bureau of Standards. The higher education sector contributes to 20% of the GERD. Research-intensive universities include the University of Cape Town (UCT), Wits University the University of KwaZulu-Natal (UKZN) and Stellenbosch University. The not-for-profit sector's share of R&D expenditures has been on a diminishing trend, performing 1% of the total R&D in 2008/09.

Cross-sector funding is substantial: business funds 11% of the R&D performed by Universities, government funds over 20% of BERD, and foreign sources fund 11% of the R&D performed by businesses, government research institutes and higher education respectively (NACI 2009). This is an indication of the degree of collaboration, sharing and dissemination of research results across sectors. Also it is important to note that the international isolation experienced during apartheid years has been successfully overcome, since the contribution of foreign funding to R&D in South Africa has grown from almost zero in 1994 to over 10% in 2008/09.

Table 2: Key performers and funders of R&D in South Africa (2008/2009)

	Key R&D performers					
Key R&D funders	**Business**	**Government**	**Higher Education**	**NPO**	**Total R'000**	***% of total***
Business	8,339	153	454	27	**8,973**	***43%***
Government	2,567	3,671	3,227	33	**9,498**	***45%***
Foreign sources	1,396	445	410	143	**2,394**	***11%***
Other	29	7	100	38	**174**	***1%***
Total R million	**12,331**	**4,276**	**4,191**	**241**	**21,039**	
% of total	***59%***	***20%***	***20%***	***1%***		

Source: South African National Research and Experimental Development Survey 2008/09.

2.2 Resource mobilisation

This section will assess the progress towards national R&D targets, with particular focus on private R&D and of recent policy measures and governance changes and the status of key existing measures, taking into account recent government budget data. The assessment will include also the human resources for R&D. Main assessment criteria are the degree of compliance with national targets and the coherence of policy objectives and policy instruments.

2.2.1 Resource provision for research activities

Progress towards R&D investment targets

The National Research and Development Strategy (NRDS) (2002) proposed an investment target of 1% of GERD as a percentage of GDP by 2008. Although R&D expenditures have been steadily increasing in nominal terms since 2002 for all sectors (see Table 3 below), at 0.92% in 2008/09, the 1% target has not yet been achieved. There has been a steady increase in GERD as a percentage of GDP from 0.81% in 2003/04 to 0.95% in 2006/07, followed by a decrease to 0.93% in 2007/08 and a further drop to 0.92% of GDP in 2008/09.

Table 3: R&D expenditures by sector 2003-2008/09 (R millions)

	2004/05	**2005/06**	**2006/07**	**2007/08**	**2008/09**	***CAGR****
BERD	6,766	8,244	9,243	10,738	12,332	*17%*
GOVERD	2,511	2,947	3,766	4,040	4,277	*14%*
HERD	2,534	2,732	3,299	3,621	4,191	*15%*
Not-for-profit	198	227	213	223	241	*3%*
Total GERD	12,010	14,149	16,521	18,622	21,041	*16%*
GERD as% GDP	**0.87**	**0.92**	**0.95**	**0.93**	**0.92**	

Source: Source: South African National Research and Experimental Development Surveys from 2003/04 to 2008/09.
*Note: CAGR= Compound Annual Growth Rate

The Ten-Year Innovation Plan launched in 2008, targeted an R&D intensity of 2% by the year 2018. The latest policy objective announcement by DST has been to increase R&D intensity as measured by GERD as percentage of GDP to 1.5% by 2014 (PMG, 2010). Each of these historic, near-term and long-term targets have been adopted as critical interventions to increase the knowledge intensity of South Africa's economy.

Research funding mechanisms

The NRDS (2002) provided long-term planning basis for research and innovation activities through a framework of indicators to monitor the performance of the S&T system at macro level. These targets have been recently revised in the Ten-Year Innovation Planand are intended to guide the direction of investments and actions until 2018 (see table 4). However, scepticism has been raised over the ability of South Africa to achieve them and a recent evaluation from the Portfolio Committee on S&T has recommended the revision of some of the targets (such as those for PhD production and GERD as % of GDP).

Table 4: RSTI targets the Ten-Year Innovation Plan (2008)

Research and technology enablers	**2018**
Matriculants with university exemption in maths and science (5.2% maths and 5.9% science in 2005)	10%
SET graduates as percentage of all students in public higher education institutions (28% in 2005)	35%
Number of SET PhD graduates per year (561 in 2005)	3,000
Number of full-time equivalent researchers (was 11,439 in 2005)	20,000
FTE researchers per 1 000 workforce employed (1.5 in 2005)	2.6
SA positioned as knowledge-based economy	**2018**
Economic growth attributable to technical progress (10% in 2002)	30%
National income derived from knowledge-based industries	>50%
Proportion of workforce employed in knowledge-based jobs	>50%
Proportion of firms using technology to innovate	>50%
GERD/GDP (0.87 in 2004; short-term 2008 target was 1%)	2%
Global share of research outputs (0.5% in 2002)	1%
High- and medium-tech exports/services as a percentage of all exports/services (30% in 2002)	55%

Number of South African-originated US patents (100 in 2002)	250

Source: DST (2008)

With these goals in mind, the Ten-Year Innovation Plan focuses on five 'grand challenges' for science and technology system over the next decade. The grand challenge areas are: (1) The 'Farmer to Pharma' value chain to strengthen the bio-economy; (2) Space science and technology; (3) Energy security; (4) Global-change science with a focus on climate change; and (5) Human and social dynamics, to apply science and technology activities to achieve the Millennium Development Goals on livelihoods and affordable access to services. Progress in all these areas is expected to be based on the three foundations: technology development and innovation, human capital and knowledge infrastructure (including the research institutions mandated to promote sector research).

Detailed targets and measurable objectives at are presented in DST's multi-annual Strategic Plans at the level of Programme Strategic Objectives and Activities. The latest has been recently released for the fiscal years 2011-2016. In the new governance framework, individual departments report on their own research and development spending. DST assists the coordination of this function through (a) developing five-year research and development plans for the whole of government, and (b) drafting a framework for the national S&T expenditure plan (NSTEP) aimed at providing a holistic view of government's total science and technology spending; and (c) introducing reforms to improve the budgeting process and the management of the S&T system. For this latter purpose, DST introduced in 2008 a new web-based Research Information Management System (RIMS) designed to collect data on research inputs, outputs and processes of the all public research institutions (including universities, science councils and other government R&D funding agencies).

In 2011 €440m (R4.4b) of public funds were allocated to R&D in South Africa, an increase of 16% from the €370m (R3.7b) in 2008. Most of these funds (58%) are allocated to seven entities that fall under DST: the Technology Innovation Agency (TIA), the National Research Foundation (NRF), the Council for Scientific and Industrial Research (CSIR), the Human Sciences Research Council (HSRC), the South African National Space Agency (SANSA), the Africa Institute of South Africa, and the Academy of Science of South Africa.

Research activities in universities and public research institutions are largely funded by the government through block funding. A large share of funding for research in business enterprises comes from the NRF and the recently established Technology Innovation Agency (TIA). NRF operates six national research facilities and manages competitive funding programmes through its Research and Innovation Support Advancement (RISA), which distributes research grants, scholarships and fellowships to researchers on a competitive basis – not only to businesses but also to HEIs and researchers in national research facilities. TIA, with a budget in 2010 of €40m (410m Rand), provides competitive funding for the commercialisation of domestic R&D (TIA has absorbed some of the prior key programmes of competitive funding namely the Innovation Fund, Tshumisano Trust and the Biotechnology Regional Innovation Centres). Other important funding agencies include the Small Enterprise Development Agency (SEDA) – that manages the Technology Transfer Fund (TTF) for small enterprises, and the Industrial Development Corporation (IDC), the Water Research Commission, the South African National Energy Research Institute, and the Medical Research Council.

There is only one tax incentive measure (R&D tax incentive programme); its impact remains still undetermined as it was only introduced in 2007, but is expected to gain momentum in the near future. Collaborative funding is a minor component of research funding although a few programmes within the NRF fund research collaboration nationally and internationally.

Trust between science and society

The South African Agency for Science and Technology Advancement (SAASTA) has an educational unit to enhance the communication of science to the public. In this regards SAASTA is involved in Science education, Science Communication and Science Awareness. In Science education, SAASTA works with schools supporting science enrichment projects and competitions, it exposes learners to career opportunities in science, engineering and technology, and it supports schools with science curriculum; enrichment materials; web-based materials; and online learning. In Science Communication programmes such as the Public Engagement of Biotechnology Programme (PUB), the Public Engagement with Nanotechnology programme (PEN) and the Hydrogen and Fuel Cell Technologies and Alternatives Public Awareness, Demonstration and Education Platform (HFCT PADE) are included. These programmes are designed to create awareness, visibility and acceptance about the benefits and safety of emerging technologies.

Main societal challenges

Inequality has defined South Africa's political economy historically and continues to be an intractable reality, with race, class, gender and geographic dimensions. Persistent inequalities imply that some segments of the population still have consistently inferior opportunities – some manifestations include endemic unemployment, high rates of prevalence of HIV/AIDS and chronic poverty. In 2004 the government committed to halving poverty and unemployment by 2014 under the Accelerated and Shared Growth Initiative for South Africa (AsgiSA). However, policy and institutional choices over the past fifteen years have skewed the research innovation systems towards the middle and upper-income segments of the economy and society. The OECD report (2007) found little evidence of R&D being explicitly engaged to advance poverty alleviation. A recent indication of progress in this set of issues is the South African HIV/AIDS Research (and Innovation) Platform launched in 2009 by DST; €4,5m (45 million Rand) have been allocated to this programme, to provide grants to organisations and research groups for basic research on HIV/AIDS. Additionally, the not-for-profit sector dedicates most of its R&D efforts to applied research on societal challenges, as indicated by the allocation of R&D according to socio-economic objectives: 60% of R&D funding goes to research on society – of which 28% goes to social development and community services and 15% to health research; whilst 28% of NPO R&D is dedicated to research on economic development, particularly on issues that address the economic framework. The NPO sector's largest source of funding is derived from international development agencies. Despite its relevance and sustained growth over the years it represents less than 1% of the total R&D. The co-existence of inequality alongside the R&D system creates a tension which must be overturned if a future growth path is to utilise the NSI for inclusive economic and social development.

Recent policy changes

Two recent policy changes that are likely to have significant impact on the research and innovation system in South Africa are: the Ten-Year Innovation Plan launched in 2008 to guide transition toward a knowledge-based economy, and the establishment of the Technology Innovation Agency (TIA) in 2009 to support the new R&D investment targets and the commercialisation of research outputs.

2.2.2 Evolution of national policy mix geared towards the national R&D investment targets

The business sector is the largest performer of R&D, spending about €1b (12.3 b Rand) in 2008/09 – a nominal increase of 14.8% from 2007. Table 3 above shows that from 2003 to 2008/09 BERD increased significantly at an average annual rate of 17% (CAGR). Businesses performed nearly 60% of the GERD in 2008/09. From 2003 to 2006 the BERD increased from 55.5% to 58.3% of total GERD, followed by a substantial drop in 2007 to 55.9% and a recovery in 2008/09 to 58.6%. As a percentage of GDP, BERD intensity has slightly increased from 0.53% of GDP in 2005/06 to 0.54% in 2008/09. BERD intensity is half of that of the EU27 economies in aggregate, at 1.1% of GDP in 2008. Another feature in comparing South African GERD to ERA countries is the significant exchange rate volatility. Between 2000 and 2010 annual average euro-rand exchange rates have fluctuated between R6.39/euro (2000) to R12.05/euro (2008). These fluctuations may distort year on year comparisons in GERD and its components.

Three quarters of business R&D in South Africa is performed by large corporations, such as foreign multinationals and State corporations like Denel, Eskom, Transnet, and the recently privatised Sasol. This explains the increase of BERD in nominal terms during the years of recession (since 2008), partly the result of the relocation of global R&D investments from large foreign multinationals, which are responsible for a large share of business R&D in South Africa. This tendency has also been observed in other catching-up economies (such as Hungary, Turkey, and Poland) that have benefited from the MNCs strategic relocation of global R&D.

However, at the same time – according to the latest innovation survey in South Africa – the dominance of large firms and the ensuing lack of competition in key sectors discourage investment from the majority of SME firms in innovation-related activities. The second most cited factor hampering innovation investments (both R&D and non-R&D) was enterprises' lack of funds, thirdly the high costs of innovation, and fourth the lack of qualified personnel. While South Africa has a strong base of industrial R&D capacity that capacity is challenged by demographic transformation and investment patterns by SMEs (Blankley and Moses, 2009).

South Africa's share of business sector R&D expenditure in total GERD (58.2%) is at the levels of EU countries (62% in 2009). Some commentators have noted that achieving the ambitious 2% target of GERD as percentage of GDP by 2018 would require boosting private sector investment through a variety of routes including:

(1) **stimulating greater R&D investment in R&D performing firms** by improving the framework conditions to invest in R&D. This is the rationale of the (a) The R&D tax incentive programme, introduced in 2007, gives a 150% tax deduction for expenditure on eligible scientific or technological R&D undertaken by enterprises or

individuals ; and the venture capital tax company incentive launched in 2009, (b) the *Tshumisano programme* supports R&D in SMEs through a technology stations programme based at Universities of Technology across South Africa, (c) the Support Programme for Industrial Innovation (SPII) assists South African industry through competitive bidding on financial assistance for technology development after the basic research phase and through until pre-production of a prototype, and (d) The Technology and Human Resources for Industry (THRIP) matches investment by industry in projects where researchers from HEIs and other research institutions serve as project leaders and students are trained through projects in industry. This latter has been recognised as a successful instrument to integrate the development of research-capable human resources with industry-university co-operation in R&D (HSRC, 2003; OECD, 2007).

(2) **promoting the establishment of new indigenous R&D firms**. This is pursued (a) through the promotion of *Centres of Excellence* (CoEs), are physical or virtual centres of research that concentrate existing capacity and resources to in order to enhance the pursuit of research excellence and capacity development; (b) *SEDA STP Technology Business Incubators*, which uses different organisational models to incubate both start-ups and enterprises requiring rehabilitation; and (c) Grants by *The Technology Innovation Agency* (TIA) set up in 2009 to support R&D investment targets and associated commercialisation of outputs. TIA provides financial and non-financial support during applied research and technology stages. It also sources foreign and domestic funding opportunities and facilitates strategic partnerships among HEIs, Public Research Organisations (PRO), the Private Sector and other relevant Government Programmes.

(3) A third route to increase private sector R&D is by **stimulating firms that do not perform R&D yet**. For this purpose, the DST and other government departments contribute to the government's '*Competitive Supplier Development Programme*' (CSDP), which aims to increase the participation of local companies in major procurement opportunities from large state owned enterprises (SOE). Also programmes such as THRIP, SPII, *Tshumisano* and the R&D Tax Incentive programmes, mentioned above, can serve to encourage non-R&D performers.

(4) The fourth route, **attracting R&D-performing firms from abroad**, is not actively pursued through explicit programmes; however, South Africa is highly favourable to foreign firms. The Trade and Investment South Africa (TISA) agency (under the Department of Trade and Industry, DTI) plays an active role in attracting foreign business in key sectors, and develops effective incentives to match those being offered by competitor countries.

Finally, (5) the fifth route, **increasing extramural R&D carried out in cooperation with the public sector**; the Ten-year Innovation recognises the importance of collaborative work along value chains to achieve the 'grand challenges', which involves reinforcing public-private collaboration in R&D and the development of collaborative approaches optimise the R&D value by state-owned enterprises. The *Technology Innovation Agency* (TIA) and the Centres of Excellence Programme (CoE) also intend to stimulate coordination of research expertise in industry, universities and public research institutes.

Recent years have experienced extensive reform concerning the policy mix supporting R&D and innovation. Multiple programmes have been developed to cover a variety of routes, particularly to stimulate local R&D. However, international and national evaluators have raised concerns about limited resources being spread too thinly (OECD, 2007; Kaplan, 2008), limiting the scale of activities and their impact. The absence of a critical mass of skills also restricts the extent to which R&D supporting programmes can be fully implemented and targets achieved. Additionally, research categories that qualify for state support may lack focus as some of the 'grand challenges' in the Ten-Year Innovation are too broadly defined (for instance human and social dynamics) (OECD, 2007; Kaplan, 2008).

Other policies that affect R&D investments

The shortage of skills is a widespread concern and has been established as the most pressing challenge for the evolution of South Africa's research and innovation systems. In 2009 the former Department of Education was divided into the Department of Basic Education and the Department of Higher Education and Training (DHET), by which DHET acquired responsibility for all post-school education and training (which partly fell before under the Department of Labour). DHET role is to improve coordination between education and training policy, and strengthen South Africa's skills and human resources base.
Affecting the industrial sector, the National Industrial Policy Framework (NIPF) was adopted by Cabinet in 2007, and its implementation spelled out in the Industrial Policy Action Plans (IPAP) is now on its second round of implementation (IPAP2). The NIPF contains an Innovation and Technology Strategic Programme as necessary condition for industrialisation. Additionally, there are a number of policy initiatives that assist with business resources in South Africa, like the Department of Trade and Industry's Small Enterprise Development Agency (SEDA) and a range of tax incentives for businesses, particularly small and micro enterprises. However, there is a recognised need for a greater support to link firms with funding, especially venture capital. In relation to this latter a venture capital tax incentive was introduced in 2009 to facilitate greater access to equity finance by small and medium businesses, with so far a limited response.

2.2.3 Providing qualified human resources

A critical constraint to the expansion of the R&D system is development of human resources. In 2008/09 South Africa counted with a total of 19,384 full-time equivalent (FTE) researchers and 31,352 FTE R&D personnel; the equivalent to 1,4 researchers per 1,000 total employment and 2,2 R&D personnel per 1000 total employment. These figures are low both by EU-27 standards (5.8 researchers per 1000 employed) and also in comparison with other middle income countries.

In 2007/08, researchers accounted for 68% of the total R&D personnel, while the remaining part were technicians (16%) and other personnel directly related to R&D (16%). Higher education institutions employed most of the R&D personnel (54.1%), followed by business enterprises (30.2%) and Science Councils (10.1%). R&D personnel has grown very slowly, at an average annual rate of 0.7% from 2004 to 2008/09 – this rate is less than half of the already sluggish 1.6% annual growth rate for the number of researchers for the same period. Despite the relatively large amount of resources invested in R&D, South Africa's pool of researchers is still very small. Some commentators have attributed this fact to the higher salaries commanded by South African research workers in comparison to similar countries

(Kaplan, 2008) – the huge skills deficit in the South African Labour Market drives up the price of all qualified participants.

Female representation in the pool of researchers is relatively high, comprising about 40% for the last five years. The HEIs sector has the largest concentration of female researchers accounting for over 73% of women researchers in South Africa. While in government (including the science councils) and business the female representation is lower (41.4% of female researchers in government and only 29.5% in business in 2008/09).

Table 5: Enrolments in Higher Education in South Africa (2005-2009)

	2005	2006	2007	2008	2009	% 2009	CAGR
Total enrolments	737,472	741,383	761,087	799,387	837,779	100%	2.6%
Level of study							
Undergraduate	621,883	630,146	650,685	680,779	709,032	84.6%	2.7%
Postgraduate	115,589	111,237	110,402	118,608	128,747	15.4%	2.2%
Doctoral degrees	*9,434*	*9,828*	*10,051*	*9,994*	*10,529*	*1.3%*	*2.2%*
Field of study							
Science, Engineering and Technology	211,069	222,985	228,735	234,607	236,254	28.2%	2.3%
Business	214,509	211,618	214,341	224,948	237,062	28.3%	2.0%
Humanities	311,894	306,780	318,011	339,832	364,463	43.5%	3.2%

Source: Department of Education (2005 to 2008) and Department of Higher Education and Training (for 2009)

In order to reach the target of 2.6 FTE research personnel per 1,000 employed by 2018, South Africa will need to devote more resources to tertiary education, engorge university enrolments and graduation rates, and possibly attract South African researchers and PhD graduates living abroad. South Africa's expenditure on higher education been estimated as 0.57% of GDP in 2007 (De Villiers and Steyn, 2007: 140), lagging behind the EU average (1.3%) and also below other BRICS countries (such as Russia and Brazil at 0.8%) (OECD, 2009). The shortage of skills is one of the most cited constraints in South Africa's research and innovation system. Building R&D capacity requires an education system capable of supplying sufficient graduates and researchers, especially at the tertiary level – these goals are referred to as 'enablers' in the main policy documents in South Africa. In 2009, 837,779 students were enrolled in public higher education (HE) institutions. The majority were in humanities-related programmes (43.5%) –including education, humanities and social sciences — compared to the lowest share in science, engineering and technology (SET)(28.3%) and business-related programmes (business and management (28.2%). While there has some progress in SET subjects, enrolments rates have grown below the 2.6% average of all subjects, at 2.3% per year from 2005 to 2009. Table 5 also shows that the public higher education sector remained primarily at the undergraduate level, accounting for 84.6% of all enrolments in 2009, including occasional courses, with only 1.3% enrolled in doctoral degrees.

The centrality of the skills shortage constraint in South Africa was recently confirmed by the OECD review, which characterised human resource development as '…perhaps the issue that will be central to all other aspects of the development of the STI system over the next decade.' (OECD, 2007: 87). This concern arises from the large gap generated by the combination of slow growth in the supply of university graduates capable of undertaking research, and the growing demand for design and engineering skills generated by the increased rate of investment across the economy (OECD, 2007: 7). The constraint imposed on the research and innovation system by a shortage of skills is likely to limit the achievements of other programmes aimed at mastering new emerging technologies as outlined in the Ten Year Plan. Moreover, the OECD review stressed that the expansion of innovative activity throughout the economy and business R&D, will only be possible if it is balanced by a considerable expansion of university research mainly to provide the necessary research capable human resources at all levels of degree qualification – concluding that the age structure and replacement rates of university researchers, may threaten not only the expansion but also the sustainability of current levels of university R&D.

At the undergraduate level one of the main instruments to boost skills development has been the National Student Financial Aid Scheme (NSFAS), which receives most of its funds from the Department of Higher Education and Training (DHET). This fund has provided financial aid to 659,000 students, and distributed more than €1b (12b Rand) in student financial aid from 1999 to 2008. However, a recent evaluation of NSFAS (2010) indicates that the programme suffers from a high rate of drop-outs (72% of the students) and a short demand due to its current structure. One of the challenges in South Africa is to improve the graduation rate (which hasn't improved for the last decade and below the international norm – in 2007 only 16,6% of HE students graduated).

At the postgraduate level: (1) The Research Professional Development Programme, is targeted at young researchers at the doctorate level conducting research in key areas in Science Councils and National Facilities, (2) The South African Research Chairs Initiative (Sarchi), focuses on development of scientific capacity in South African HEIs by increasing the number of internationally recognised researchers through specially funded positions. This programme also indirectly attracts skilled South African researchers living abroad. (4) The Postdoctoral Fellowship Programme, seeks to encourage enriching high level HRST capacity in South Africa, (5) The Centres of Excellence (CoE) Programme provides concentrated opportunities for development of high-level skills and specialisation in SET and (6) The Women in Science Awards, which encourage women to enter and remain in SET careers through several categories of annual awards recognising scientific excellence by South African women. Regarding this aspect, it is interesting to note that South Africa has a good representation of female students in higher education, accounting for 57% of the enrolments in 2009.

Although there are some initiatives locating entrepreneurial research at HEIs (e.g. Tshumisano Technology Stations Programme at Universities of Technology) there is a shortage of Masters and Doctorate programmes in entrepreneurship and innovation. "Soft skills" (i.e. creativity, problem solving, teamwork, communication skills, etc) are still not widely integrated in the curricula.

2.3 *Knowledge demand*

This section focuses on structure of knowledge demand drivers and analysis of recent policy changes.

South Africa's expansion of GDP at an annual average rate of over 3% from the late 1990s to 2008, suffered from a contraction of 1.7% in 2009 mainly due to the global economic recession. The expansion over this decade was mainly driven by a structural change in the sources of competitive advantage from the primary sector (mostly mining) to a service-based economy. As a result, South Africa has made a significant move towards a knowledge-based economy, with a greater focus on technology, e-commerce and ICT services. The service sector has been the most dynamic during the 1990s and 2000s accounting for 70% of the total GDP in 2010. Within the service sector, finance, real estate and business services are responsible for the largest share, nearly 25% of the GDP. Manufacturing (including construction) is the second largest contributor to the economy, responsible of 20% of the total output. The manufacturing sector has been historically concentrated in a few sub-sectors (i.e. automotive industry, basic chemicals, iron and steel). The manufacturing sector was in a declining trend from 1995, but its rebound in the last two years has been a key driver behind the recovery of economic activity in 2009-2010. The growing external demand for mining products, particularly from China, has also pushed a recent turnaround in the mining sector. The total GDP expanded 2.8% from 2009-2010.

In terms of sectoral composition of R&D, the business enterprise sector is the largest performer of R&D in South Africa. BERD totalled €1,2b in 2008, the equivalent to 58% of GERD. Moreover, business funded 70% of these expenditures. Most BERD was devoted to experimental development, which accounted for 63% of BERD, followed by applied research (29%) and basic research (8%). BERD was mainly concentrated in the field of natural science, technology and engineering (97% of BERD), with social sciences and humanities comprising the remaining 3%. In terms of socio-economic objects of BERD, economic development was the main inclination (78% of BERD), followed by society (9%), defence (8%), advancement of knowledge (3%), and environment (1%).

The demand for knowledge is intrinsically linked to the productive structure of the South African economy. An important feature of the South African economy is the co-existence of two economic domains in South Africa that are commonly named as the 'first' and 'second' economies. The 'first economy' represents the modern and growing economy of South Africa based on manufacturing and service sectors, which increasingly integrated in the global markets produces the bulk of the national wealth. The 'second economy' is represented by the rural and agricultural sectors which are constrained by poverty and marginalisation. Gauteng and the Western Cape have become representatives of the first economy as the leading industrial provinces, dominated by business enterprises and research institutions that consume R&D products and services from other sectors such as financial services and ICTs. However, many of the challenges faced by the 'second' economy also require R&D-based solutions. One of the main challenges of the innovation system is to find mechanisms for articulating the knowledge demands from the second economy and promote relevant R&D accordingly. As Table 6 shows, manufacturing and financial services account for 65% of the BERD.

Table 6: Sectoral distribution of BERD (2008)

SIC Classification	Percentage of BERD
1 Agriculture, Hunting, Forestry and Fishing	2.0%
2 Mining and Quarrying	5.2%

3 Manufacturing	39.3%
4 Electricity, Gas and Water Supply	16.2%
5 Construction	0.1%
6 Wholesale and Retail	3.0%
7 Transport, Storage and Communication	4.6%
8 Financial Intermediation, Real Estate and Business Services	25.7%
9 Community, Social and Personal Services	4.0%

Source: *National Survey of Experimental Research and Development 2007/08, DST 2009*

In its Ten-Year Innovation Plan (2008-2018), The DST envisages a series of major R&D advances in the area of energy, such as clean coal technologies, nuclear, renewable energy and hydrogen and fuel cells. In this domain there are two actors worth mentioning. Firstly, in the private sector, SASOL (an energy and chemicals company) is the single largest R&D performer in the business sector (25% of total BERD), mostly involved in research on conversion of coal and liquid natural gas to oil. Secondly, Eskom (the state-owned electricity generator and distributor), has been developing the Pebble Bed Modular Reactor (PBMR) since 1999 (to be completed in 2012), with a budget of about €100m (1b Rand) per annum.

The breakdown of government R&D expenditure by field of science indicates that the domain of 'natural sciences, technology and engineering' is still predominant (75.7% of GOVERD). However, from 2005/06 to 2007/08, in relative terms this area of research has lost ground against social sciences and humanities as share of GOVERD (from 78.3% to 75.7%). In 2007/08, R&D expenditure in the government sector was highest in the field of social sciences, which accounted for 20.4% of total expenditure. Mathematical sciences, applied sciences and technologies, environmental sciences and marine sciences experiment dropped considerably during this period both in absolute and relative terms. This trend threatens the achievement of some of the 'grand challenges' as described in the Ten-Year Plan, such as positioning South Africa as a world leader in climate change research. Agricultural sciences, medical and health sciences and earth sciences jointly concentrate nearly half of the GOVERD and have increased substantially in recent years.

Table 7: GOVERD by research field (2005/06 and 2007/08)

	2005/06	2007/08	Variation in nominal terms
Division 1: Natural sciences, technology and engineering	***78.3***	***75.7***	32%
Mathematical sciences	2.5	1.8	-4%
Physical sciences	3.2	3.9	66%
Chemical sciences	1.3	2.0	112%
Earth sciences	11.9	14.0	61%
Information, computer and communication	5.0	7.1	95%
Applied sciences and technologies	2.1	1.3	-12%
Engineering sciences	1.2	1.2	37%
Biological sciences	9.4	9.8	43%
Agricultural sciences	18.5	18.1	33%

Medical and health sciences	16.3	15.1	26%
Environmental sciences	4.7	0.7	-78%
Material sciences	0.0	0.1	323%
Marine sciences	2.1	0.6	-58%
Division 2: Social sciences and humanities	***21.7***	***24.3***	53%
Social sciences	16.5	20.4	69%
Humanities	5.2	3.9	3%
Total	***100***	***100***	37%

Source: National Survey of Experimental Research and Development 2007/08, DST 2009

2.4 *Knowledge production*

The production of scientific and technological knowledge is the core function that a research system must fulfil. While different aspects may be included in the analysis of this function, the assessment provided in this section focuses on the following dimensions: quality of the knowledge production, the exploitability of the knowledge creation and policy measures aiming to improve the knowledge creation.

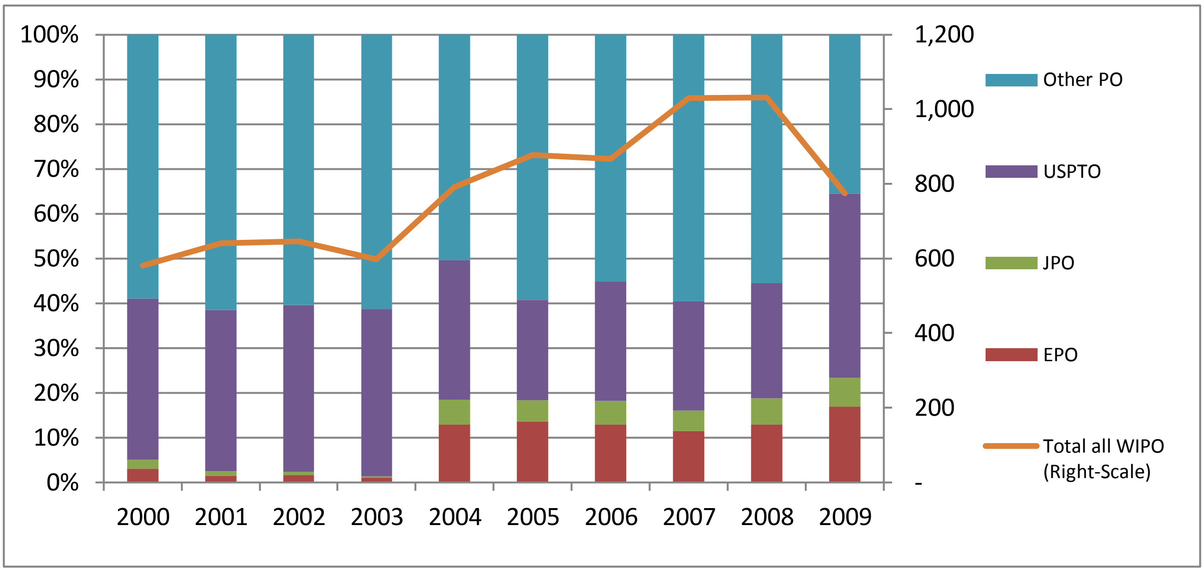
2.4.1 Quality and excellence of knowledge production

As explained in earlier sections, inputs to knowledge production in South Africa have progressed at different rates. Although GERD has grown in nominal terms from 2005 to 2008/09 at an average annual rate of 16%, GERD as percentage of GDP is currently at the same level as 2005 (0.92%). Fuelled by the growing investments from the private sector, GERD reached €1,2b in 2008/09, while the R&D intensity of the business sector reached 0.54% of the GDP in 2008/09. In between 2005 and 2008/09, GERD per capita increased from €21.5 to €29.1. Human resources, a key enabler of R&D performance, have grown at a much slower rate. Research personnel reached a total of 19,384 FTE in 2008/09, while R&D personnel was 31,352 FTE, expanding at a rate of 2% and 1.4% per year respectively since 2004/05.

In terms of output, South Africa has an established record of research and knowledge production. The number of scientific publications is a widely used indicator of the quality of research production as well as an important determinant of research funding in HEIs, in South Africa and elsewhere. South Africa produced 7,045 articles in ISI-listed journals in 2009, a 10% increase as compared to 6,356 in 2006. Publications concentrate in the area of natural sciences (32%), medicine (31%) and life sciences (18%). Scientific publications emerge mainly from the top five research-intensive universities (Cape Town, Witwatersrand, Pretoria, KwaZulu-Natal and Stellenbosch University), which account for about two thirds of all publications in the country. It is worth mentioning that international collaboration in scientific publications have also been on the rise, with an observed higher co-publication with foreign parties (mainly Universities in Europe and the US) – including prolific collaborating institutions with top universities such as Oxford, Harvard, Columbia Universities and the London School of Tropical Medicine in health-related publications focused on infectious diseases (Kahn, 2010).

The national patent office (Companies and Intellectual Property Registration Office – CIPRO) recorded steady growth in patent applications between 2003 and 2007 (from 10,000 to over 10,800) before a significant fall in applications in 2008. Patent applications from South Africans citizens at other patent offices internationally, tracked by the World Intellectual Property Office (WIPO), followed a broadly similar pattern, with applications growing until a sharp decline in 2009 – see Figure 4 below. In terms of locations where South Africans applied for and/or were granted a patent abroad, the United States Patent and Trademark Office (USPTO) was the primary office where protection was sought, but particularly after 2004 there has been a noticeable increase in applications and grants from the European Patent Office (EPO) to South Africans.

Figure 2: Patent Applications from South Africans (WIPO)



Source: *WIPO (2011)*

2.4.2 Policy aiming at improving the quality and excellence of knowledge production

Although there is a clear need to improve the efficiency and effectiveness of the research and innovation systems, South Africa does not yet have a structured mechanism to monitor and evaluate the research performance of private or public institutions. Therefore, there is no standard and consistent monitoring and evaluation framework to determine the performance of the various actors in the system.

The performance of public organisations, including public research institutes, higher education institutions and science councils is monitored and published in their annual reports. Some capacities to monitor research performance have been developed in the two advisory councils (The National Advisory Council on Innovation (NACI), and the Council on Higher Education (CHE) responsible of advising the DST and DHET respectively. CHE has a Monitoring and Evaluation Directorate, responsible for monitoring the activities of higher education institutions. However, its functions relate almost exclusively to the assessment of the quality of teaching and learning rather than research activities.

At the level of policy strategy, part of the oversight task of the Portfolio Committee on Science and Technology is to specifically evaluate some elements of the strategic and annual performance plans as presented by DST. The DST monitors its performance through the targets included in the Ten-year Innovation Plan and other commonly used indicators for tracking the country's progress in STI. However, there is still a need for regular and systematic performance evaluation. The Strategic

Management Model (SMM) of South Africa's public S&T system approved by Cabinet in 2004 recommended that DST should submit a national S&T expenditure plan to Cabinet annually. For this purpose a DST launched in 2008 an integrated Research Information Management System (RIMS). This web-based tool is currently being implemented and is designed to collect statistical information on R&D activities (inputs, outputs and processes) by universities, Science Councils and other government R&D funding agencies. RIMS is in the stage of implementation and it is planned to be fully operational by 2013. This system will be critical for policy making and the monitoring of the Science & Technology capacity and research productivity. However, its successful implementation and maintenance will require considerable human capital development.

2.5 Knowledge circulation

This section provides an assessment of the actions at national level aiming to allow an efficient flow of knowledge between different R&D actors and across borders

2.5.1 Knowledge circulation between the universities, PROs and business sectors

Cross-sector funding gives an indication of the degree of research collaboration and circulation of knowledge across sectors. Section 2.1 showed that in 2008/09 cross funding of R&D was significant: the business sector funded 4% of GOVERD and 11% of HERD, whilst foreign sources funded about 10% of R&D performed in all sectors. However, looking at the evolution of cross-sector funding over time, we see that business enterprises are funding less R&D activities in other sectors in 2009 than in 2006, especially with HEIs (dropping their funding of HERD from 21% in 2006 to 11% in 2009). On the contrary, foreign funding of R&D has increased across the board although not very significantly (around 1-3% increase in each sector). The Ten-Year Innovation Plan (2008) envisages that the foreign funding component of should increase to 15% of the total GERD in 2018, which could be achieved if this rate of growth continues.

The concept of a National System of Innovation (NSI) is at the basis of recent national strategies for research and innovation, recognising the importance of knowledge-based interactions across multiple agents, including the private sector, universities, government organisations and civil society. With this goal in mind, The Technology Innovation Agency (TIA) was established in 2008 to stimulate the development of technology-based products and services. TIA provides financial support to the NSI through a number of financial support instruments as well as technical support, technology nurseries, and commercialisation advice for technology development and the commercialisation of technologies. Most of TIA's programmes to fund innovation and R&D activities have amongst their objectives the facilitation of knowledge circulation and interactions between HEIs and industry. In fact, THRIP (described in section 2.2.1 above) is specifically designed to foster collaboration among industry, HEIs and SETIs by: (a) funding business research projects where project leaders are on the academic staff of South African Higher Education Institutions (HEIs), (b) matching investments by industry in projects where researchers from Science, Engineering and Technology Institutions (SETIs) serve as project leaders and students are trained through the projects, and (c) promoting the mobility of researchers through the Transfer Of People (TIPTOP) schemes that promote the mobility of researchers and students between the industrial participants, HEIs, and SETIs. This instrument has been examined by several observers and has been recognised as a successful instrument to integrate the development of research-capable human resources with industry-university co-operation in R&D (HSRC, 2003; OECD, 2007).

Some of the sectoral platforms under TIA that have been developed to facilitate knowledge circulation include the Biotechnology Regional Innovation Centres (BRICS), the Advanced Manufacturing Technology Strategy (AMTS), and the Tshumisano Trust. These platforms have bridged graduates and R&D outputs from universities to firms (especially SMEs) in selected sectors to improve the competitiveness and innovation capacity. The Ten-Year Innovation Plan (2008-2018) continues with this tradition, acknowledging that progress in the five identified 'grand challenges' can only be achieved through greater networking and collaboration (domestic and international) across all sectors (academia, science councils, industry and government).

Other instruments that facilitate the circulation of knowledge generated in research institutions and industry are: the Patent Support Fund of DST, which supports commercialisation of the inventions and innovations arising from the research institutions, covering up to fifty percent (50%) of the patenting costs of students and researchers. Also, the Seed Fund offered by DST, which facilitates the transition to the stage of commercialisation of R&D products. It has been designed for researchers who have a prototype finalised but need the start up capital to begin the marketing and distribution process. Finally, more recently, the Intellectual Property Rights from Publicly Financed Research and Development Act 51 was passed in 2008. The Act intends to stimulate innovation and economic growth by the identification of commercialisation opportunities arising from publicly funded research and development.

2.5.2 Cross-border knowledge circulation

Given South Africa's isolation during apartheid years, international collaboration and cross-border knowledge circulation have been central preoccupations in STI policy since the late 1990s. DST is the primary agency responsible for policies and instruments to enhance international knowledge circulation. These are organised under three subprogrammes: (1) *Overseas/bilateral Cooperation Programme*. Since 2009 this new international cooperation strategy has commenced to be implemented in order to align international relationships with both the Ten-Year Innovation Plan and the National Research and Development Strategy (NRDS). (2) *Multilateral Cooperation and Africa*. This programme develops South Africa's participation in strategic African bilateral agreements and multilateral organisations on STI. The sub-programme strives to attract FDI into the science system and promote S&T networks through strategic multilateral partnerships. Its focus on Africa includes deepening S&T linkages with regional and African partners and implementing the Southern African Development Community (SADC) STI Protocol as well as the African Union/ New Partnership for African Development (AU/NEPAD) Africa's Science and Technology Consolidated Plan of Action (CPA), which are designed to increase knowledge production, build capacity, and enhance technological innovation regionally and across the Continent. Finally (3) *International Cooperation and Resources* sub-programme works to increase the inflow of resources by facilitating access to international STI skills and global projects. These efforts include maintaining highly functional bilateral and multilateral relationships with international partners for the benefit of South African STI. Its efforts are also targeted at integrating partnerships with donor countries into the DST's national and regional S&T activities.

ESASTAP is the European-South Africa Science and Technology Advancement Programme for enhancing EU-SA S&T co-operation. This programme has significantly increased South Africa's knowledge and participation in the Framework Programmes (FPs) and other cooperation mechanisms, targeting research areas of mutual interest. Some of the tools used include workshops, conferences and also supporting the mobility of researchers and S&T networks between Europe and South African scientists and institutions. Under the Seed Funding Instrument, the DST is able to support the travel costs of South African researchers travelling to Europe and vice versa.

Maintaining and operating research infrastructure are complex activities requiring specialised skills, which are in short supply. To address this issue, under the Research Infrastructure Support programme offered by NRF and DST, the 'Equipment-related Mobility Grants' facilitate the mobility of researchers to access state-of-the-art research equipment that is not available nationally. This latter grant aims at enhancing research collaborations and supporting the development of specialised skills required to sustainably manage and operate state-of-the-art research equipment. In 2006, the National Advisory Council on Innovation conducted a comprehensive study of South Africa's research infrastructure requirements. South Africa participates in international research infrastructures, such as CERN on nuclear physics and the Square Kilometre Array (SKA) project, in which South Africa is a strong candidate to host the world's most powerful radio telescope.

2.6 *Overall assessment*

Despite its enduring significance, there are indications that South Africa's contribution to global research output has lagged other emerging economies and not contributed enough to its socio-economic development. Increasing the knowledge output has therefore become a key policy priority. To mobilise resources several investment instruments have been developed over the past five years. New targets for the R&D system have been set up in the Ten-Yen Innovation Plan, including rising R&D investment to 2% of GDP. However, the qualitative and quantitative transformation of the national human capital pipeline (the 'enablers' such as the number of SET graduates and PhDs, as well as number of researchers) remains a critical priority. Policy efforts to address this issue have led to tentative results, but as yet the quantum of skilled human capital required for the rapid development of the national R&D system remain insufficient.

Table 8: Summary of main policy related opportunities and risks

Domain	Main policy opportunities	Main policy-related risks
Resource mobilisation	For its overall level of economic development there is a relatively high-level of business R&D activities to support government targets	Targeted incentives oriented toward elite niche fields and sectors rather than leveraging resource-based sectors and their associated innovative services
Knowledge demand	Attractive capacity for FDI investment in NSI, significant base upon which to build.	Need to leverage broader knowledge intensity in order to expand development opportunities or else risk social exclusion.

Knowledge production	Relatively developed, albeit not necessarily inclusive, systemic capabilities.	Terrific necessity to ensure that socially representative human resources in SET are developed to sustain existing and expand the NSI
Knowledge circulation	Systemic approach to applying science, technology and innovation for inclusive sustainable development	Frequent identification of research system with government linked institutions as critical player rather than innovation system with established innovators in the business sector

Table 9: Main barriers to R&D investments and respective policy opportunities and risks

Barriers to R&D investment	Opportunities and Risks generated by the policy mix
Scarce human capital in SET	- Deficit of skills hinder the possibilities to boost R&D investments by the private sector - Policy targets in human resources could be better aligned to leverage the opportunities from a relatively large share of BERD. - Creation of the Department of Higher Education and Training (DHET) can improve coordination between education and training policy, but important to tackle the existing right rate of drop-outs in higher education. - Deepening international S&T cooperation creates a critical opportunity for skills development - Employment equity and immigration policies limit the career opportunities for skilled other African Nationals in South Africa.
Focus on medium and high technologies	- Low-tech and medium tech manufacturing competitiveness creates a further need for policy support, but these competencies have not been targeted as intensively as niche high-tech areas. - The minerals-energy-complex has significant research capabilities and competitive human capital capable of contributing significantly to R&D investments if supported systematically by South Africa's R&D policy.
Geographic and demographic inequality in the knowledge system	- Persistent inequality and clustering of R&D in industrial regions limits R&D investment opportunities to geographic and demographic minorities - R&D in poverty reduction programmes needs urgent attention
Need for better policy coordination	- Creation of the Technology Innovation Agency (TIA)
Inadequate monitoring and evaluation mechanisms	- Research Information Management System (RIMS)

3 National policies which correspond to ERA objectives

3.1 Labour market for researchers

3.1.1 Stocks and mobility flows of researchers

Ensuring an adequate supply of researchers is one of South Africa's five Grand Challenges in its Ten-Year Plan for Science and Technology. In 2008/09 South Africa counted with a total of 19,384 full-time equivalent (FTE) researchers and 31,352 FTE R&D personnel; the equivalent to 1,4 researchers per 1,000 total employment and 2,2 R&D personnel per 1000 total employment. Increasing the supply of HRST is a priority in the Ten-Year Innovation Plan. However, alongside increasing the supply of researchers and R&D personnel, it is essential to establish and maintain a labour market that ensures that these skills are demanded, used and retained. In South Africa much of the data on the mobility of researchers remains under-reported.

Concerns have been often raised that top South African researchers tend to migrate to developed countries with more attractive R&D environments – although the estimations are varied and the extent of the 'brain drain' remains indefinite. It has been estimated that about half of the skilled South Africans living abroad are academics/researchers in a variety of fields (engineering, natural sciences, health, humanities, etc). An important initiative that develops ties with South African researchers abroad is the South African Network of Skills Abroad (SANSA). Other commentators have highlighted the existence of other type of migration of researchers from R&D jobs to non-R&D jobs (managerial and specialist positions) within South Africa, attracted by higher remunerations (Kahn et al, 2004).

3.1.2 Providing attractive employment and working conditions

The higher education sector concentrates the majority of the country's researchers (54% of the R&D personnel and 70% of the total FTE researchers). The DST is working with the Department of Higher Education and Training (DHET) to address human capital challenges in the SET strategy for universities. The R&D marketplace still suffers racial imbalances with 56% of the employed R&D personnel being white. This imbalance rises with the level of qualification: 73% of the R&D personnel with doctoral qualification, 61% with Masters Degree of equivalent, and 42% with a Diploma are white. The DST is also currently developing a Human Capital Development Strategy for Research and Innovation, which aims to address these imbalances by supporting a new generation of researchers representative of the entire population, and assisting them to become established researchers. While these strategies are being developed advancement of human capital remains vested within organisational priorities of HEIs and PROs although broadly supported by national research grants, endowments and knowledge generation incentives.

Given the problem with migration of researchers (both abroad and across sectors) the South African government has taken a number of initiatives to make research careers more attractive. Some of them have been explained in section 2.2.3 and include: the Research Professional Development Programme, the South African Research Chairs Initiative (Sarchi), the Postdoctoral Fellowship Programme ,The Centres of Excellence (CoE) Programme and the Women in Science Awards. It has also been mentioned that South Africa' s research capacity in a particular technology is likely to exert a great influence on the mobility and potential entry of R&D personnel and researchers in that field. Therefore, sectoral research priorities in a few key technologies linked to the 'grand challenges' are likely to influence the mobility of researchers over the next decade.

Female researchers account for about 40% of total researchers – this percentage has remained relatively static for the last 5 years – and three quarters of them are employed in HEIs. Maternity leaves, career breaks, wages and so forth are guided by the Employment Equity Act (EEA) (1998), and South Africa's National Policy Framework on Women's Empowerment and Gender Equality (NPFGW), adopted in 2000. Although shortcomings remain (such as gender stereotyping, lack of flexibility options for women, unequal remuneration, etc), there is lack of systematic data regarding recruitment, retention and advancement of women in research environments. Some institutional advances include: (1) The Science, Engineering and Technology for Women (SET4W) is an advisory committee established in 2003 comprising comprises of a team of experts who works through the National Advisory Council on Innovation (NACI) to advise DST on gender mainstreaming in the science, technology and innovation environment (STI); and (2) In 2010 a set of 'Principles and Good Practice Guidelines for Enhancing Women's Participation in the STI' was launched by DST. Despite these valuable efforts, a measurable strategy to advance women's leadership in STI remains absent.

3.1.3 Open recruitment and portability of grants

South Africa has since liberation in 1994 seen a considerable inflow of expatriate SET skills from other parts of Africa. While many restrictions for students specify South African Nationals, other funds and research posts are typically open to any qualified individual with the requisite (inherently scarce) skills. However, promotion and career advancement of these individuals can be constrained by Employment Equity regulations that explicitly preclude foreign nationals from targets. In practice, many employers did not differentiate between Black South Africans and other Black Nationals, but there is little systemic evidence to support this as equity targets are tracked primarily through self reported classifications.

The NRF Rating System also provides individual researcher level grants, but the rating system has been questioned and portability of grants tends to be limited.

3.1.4 Meeting the social security and supplementary pension needs of mobile researchers

Most HEIs and PROs have competitive pension plans that are vested with their individual organisation these will generally be transferred when changing employers. In general, there are no specific provisions available for researchers to transfer their pensions, nor are their national supplements to researcher pensions or their social security benefits.

3.1.5 Enhancing the training, skills and experience of researchers

Regional and international collaboration are central to DST's strategy of human capital development (HCD). This strategy led to €1m in official development assistance for HCD in addition to €15.2m that was received in 2009. In addition, DST, DHET, and the Department of Home Affairs are developing a skills-importation strategy for scarce and exceptional skills. That strategy has to address a cumbersome quota system for companies seeking individuals whose exceptional skills are not readily available, as first it must be proven that the skills of the foreigner are not available by any individuals in the South African job market. Collaborative leveraging of resources is also being used by DST domestically to enhance HCD. In this regard, DST is working to improve linkages between its national research facilities and public HEIs by making provisions for related departments at HEIs to utilise laboratory space and equipment at national research facilities with the intention to expand HEIs capacity to enrol master's and doctoral students.

Accreditation (institutional and programme accreditation) is mandatory for both public and private providers of higher education. The Council on Higher Education (CHE) is an independent statutory body responsible of ensuring that all higher education programmes meet minimum quality and aligns with international standards; this includes Master’s and doctoral programmes.

Some other programmes that support the international mobility of researchers are explained in section 2.5.2, such as ESASTAP that facilitates EU-South African mobility of researches; and the Equipment Related Mobility Grants, which supports access of researchers to equipment that is not nationally available.

3.2 *Research infrastructures*

Research infrastructures (RIs) are a key instrument in the creation of new knowledge and, by implication, innovation, in bringing together a wide diversity of stakeholders, helping to create a new research environment in which researchers have shared access to scientific facilities.

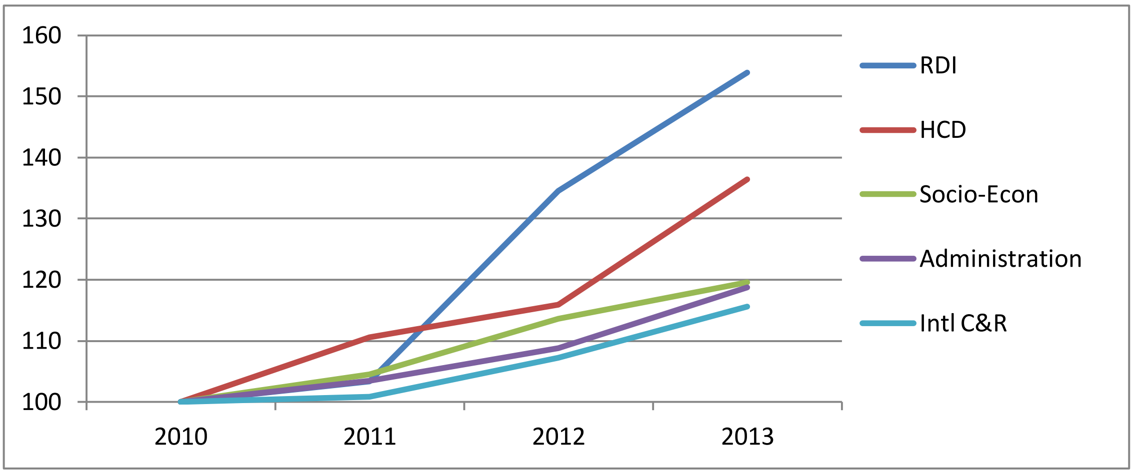
3.2.1 National Research Infrastructures roadmap

In order to complement its targeted HCD, South Africa has initiated a National Strategic Infrastructure Programme targeting investment in high quality research equipment and infrastructure. The Programme has identified five critical areas for investment: 1) Scientific equipment 2) Specialised facilities – physical and organisational structures that ensure the optimal performance of research equipment 3) Cyberinfrastructure 4) High-end infrastructure – infrastructure at the interface between research and development, and commercialisation and 5) Global infrastructure – networked international infrastructure both single-sited and distributed. DST prioritises these areas through its Medium Term Expenditure Framework (MTEF) that annually guides medium-term (five year) expenditures by the department.

In 2006, the National Research Foundation (NRF) in partnership with DST initiated the Research Infrastructure Support Programme (RISP) Grants that support the acquisition, upgrade and development of state-of-the art research equipment. As a consequence, two sub-programmes, the National Equipment Programme (NEP) and the National Nanotechnology Equipment Programme (NNEP) were established. (1) The NEP is designed to improve the competitiveness and expand the capacity of South African research and training. This programme facilitates the acquisition of large and/or specialised equipment likely to advance scientific research and train students to compete in a knowledge-based economy. The applicant’s institution is required to contribute one-third towards the purchase price of the equipment. (2) The National Nanotechnology Equipment Programme (NNEP)intends to position South African research globally in the emerging areas of nanoscience and nanotechnology by supporting the acquisition of equipment and human capacity development in the critical socioeconomic areas of Water, Energy, Health, Chemical and Bio-Processing, Mining and Minerals, Advanced Materials and Manufacturing. Finally (3) the 'Equipment-related Mobility Grants', facilitate researchers' access to access state-of-the-art research equipment that is not available nationally. This latter grant aims at enhancing research collaborations and supporting the development of specialised skills required to sustainably manage and operate state-of-the-art research equipment.

Programmatic expenditures totalled €424m in 2010. These have been relatively stable in composition in the period between 2007 and 2010. While most areas have maintained their share over time (Administrative, International Cooperation and Resources, and Human Capital & Knowledge Systems), the share on Research and Development Infrastructure (RDI) has increased over the last 3 years from about 15% to 18% of total expenditures(, while the share towards Socio-Economic Partnerships has declined. As Figure 6 shows, planned programmatic expenditures are envisioned to increase significantly in the RDI programme as well as the HCD programme. Relative expenditures in Socio-Econ are planned to further decrease.

Figure 3: Relative Programmatic Shares of the DST Budget 2011-2013



Source*:* *DST Strategic Plan for the Fiscal Years 2011-2016, DST 2011*

3.3 *Strengthening research institutions*

This section gives an overview of the main features of the national higher education system, assessing its research performance, the level of academic autonomy achieved so far, dominant governing and funding models.

3.3.1 Quality of National Higher Education System

Higher education in South Africa is dominated by 23 public universities, which are differentiated by theoretically-orientated "Traditional Universities" (11) that offer undergraduate and post graduate degrees and research capacity, combined academic and vocationally oriented "Comprehensive Universities" (6) and vocationally-oriented "Universities of Technology" (6) that offer undergraduate and post-graduate degrees and research capacity. In addition to these public universities there are 109 registered private higher education institutions but these institutions are overwhelming focused on instruction rather than research. Significant progress has been made in empowering the Black community to attend the Historically White Universities (HWUs). However, access to higher education remains constrained by the severe unequal distribution of income. The National Student Financial Aid Scheme (NSFAS) helps poorer students to access to higher education. Although the proportion of students from disadvantaged backgrounds has increased, also have drop-out rates – unable to supplement the additional costs of higher education student often fail to complete their studies. Additionally, the burden of student debt discourages people from taking higher degrees (OECD, 2007). There is a minimum admissions requirements for all programmes, but universities can set their own admissions policies beyond those minimums.

Table 10: Enrolments and graduates in SET in the HE system in South Africa (2000-2008)

	2000	2001	2002	2003	2004	2005	2006	2007	2008
Total Enrolment	578,134	627,277	667,182	705,255	744,478	735,073	741,380	760,889	799,490
Total number of graduates	92,819	95,940	101,047	108,263	117,240	120,385	124,676	126,618	133,241
Total number of SET graduates	23,679	24,907	27,240	29,495	31,436	33,506	35,562	36,429	38,819
SET as % of Total Graduates	25.5%	26.0%	27.0%	27.2%	26.8%	27.8%	28.5%	28.8%	29.1%

Source: Department of Higher Education and Training: Higher Education Management Information System (HEMIS)

In addition to these universities, South Africa has further education and training (FET) colleges that offer post secondary qualifications below the level of HEIs. There were in 2009 275 public FET colleges and 344 private FET colleges with combined enrolment of 280,000 (DHET, 2009).

The significant expansion of the supervisory and research capacity of universities is dependent on the number of academics and researchers with doctoral degrees. Currently only 34% of all university academics have a doctoral degree (2008 HEMIS data). It will require significant and sustained investment to achieve the long-term target of 80% of all university academics having a doctoral degree. Research and Development expenditures by HEIs (HERD) totalled €425 million in 2008/09, accounting for 20% of total GERD. HERD is being increasingly funded by the government. In 2004/05 government funded 63% of all HERD while the rest was funded by the business sector, foreign and other sources, However, in 2008/09 government funded 77% of all HERD. And the business contribution to HERD had dropped from 20% in 2006/07 to only 14% of these expenditures. Basic research accounted for 47% of HERD, followed by experimental development 35% and experimental development 18%. The natural science, technology and engineer fields accounted for the largest share (66% of HERD) with Social sciences and humanities comprising the remaining 34%.

According to the ranking Web of World Universities, South African universities are at the top of African Universities (9 out of the top 10 African universities are South African). However, the Academic ranking of World Universities (ARWU) for 2010 indicates that the University of Cape Town is the only South African university in the Top 300 of the Shanghai university rankings, followed by University of Witwatersrand and University of KwaZulu-Natal that make it into the Top 500. South Africa's contribution to global publications is rather small with 0.61% of scientific (ISI) publications in 2009 (a modest increase since 1995 when it was 0.51%). It has been suggested that the slow rate of growth in publications is likely to delay accomplishing the target of 1% of global ISI publications set by 2018 until 2022 (NACI, 2009). In 2009, South Africa published 7,045 articles in ISI-listed journals, compared to 6,356 in 2006 (NACI, 2009). The top universities in the country produce about two thirds of all publications in the country (Cape Town, Witwatersrand, Pretoria, KwaZulu-Natal and Stellenbosch Universities). Despite the concentration of publication activity in a few universities, International collaboration in scientific publications has been on the rise, especially with top Universities in Europe and the US – see section 2.4.1.Quality assurance is the responsibility of the statutory advisory body, the Council on Higher Education (CHE). Its Higher Education Quality Committee (HEQC) conducts audits of universities.

3.3.2 Academic autonomy

Universities are autonomous institutions regarding methods of teaching and assessment, research, establishment of academic regulations and the internal management of resources. However, they are accountable to the Department of Higher Education and Training. Autonomy within each of South Africa's HEIs is vested within a Council. The Council's responsibilities include determining the mission, objectives, goals, strategies and policies for the progress of the institution. It must also ensure an environment conducive to efficient, effective, economical and ethical attainment of these goals. In addition, the Council has the responsibility of maintaining and ensuring a financially secure, healthy and viable environment and is ultimately responsible for all decisions made at the institution. At least 60% of the Councils' membership must consist of the executive officers, and other internal stakeholder of the institution (staff, faculty, and students), while the rest of members are made up of a wide range of external stakeholders. South African HEIs are also required to have Senates who are accountable to the Council for all the teaching, learning, research, community engagement and academic functions of the University. The institution's Senates consists of internal constituents and usually include the Vice-Chancellor and Deputy Vice-Chancellors, the Deans and Deputy Deans of faculties, the Heads of Departments, the professors, peer elected faculty, staff and student representatives. Day-to-day management and administration of the University is handled by the institutions' executive officers.

3.3.3 Academic funding

The government is the largest funder of the research activities in HEIs in South Africa. In aggregate 87% of HEIs budgets were derived from block funding. These block funds include incentives for research outputs from faculty which account for approximately 12% of HEI budgets. The New Funding Framework (NFF) for Public Higher Education has been applied by the government since the 2004/05 financial year. Funding allocations are tied to research outputs of performance weighed by (a) publication units; (b) research masters graduates, and (c) doctoral graduates. The formula applied produces different grants for different institutions.

3.4 Knowledge transfer

This section will assess the national policy efforts aimed to promote the national and trans-national public-private knowledge transfer.

3.4.1 Intellectual Property Policies

Intellectual Property Rights from Publicly Funded Research and Development Act of 2008 was adopted to ensure that taxpayers' investment in research at higher education institutions and through government-funded projects is protected by patents and other forms of intellectual property protection and that South Africans benefits from the projects in the form of job creation, business creation and access to the new products. The act compels universities to establish technology transfer offices (TTOs). These offices are responsible for screening the invention disclosures made by academic researchers for commercial and/or social benefit, and then deciding on the appropriate form of protection. The act also provides for the establishment of regional offices in cases where IP output does not warrant individual offices.

In order to put a mechanism in place to encourage, monitor and quantify intellectual property resulting from publicly funded R&D, DST is currently establishing a National Intellectual Property Management Office (NIPMO). This office will also foster development of the TTO at public HEI and public research institutions to identify, protect and, where appropriate, commercialise their intellectual property. The recently established Technology Innovation Agency (TIA) will complement NIPMO by actively promoting commercialisation and technology transfer by and at South African research institutions.

Spinoffs

Policy strategy has given priority to a few technology platforms that have attracted significant research funding through a range of direct and indirect mechanisms. Such funding has created a set of positive conditions to facilitate the creation of spin-off companies from universities and research institutions in sectors such as biotechnology and space technology. The generation of spinoffs is facilitated by certain programmes such as Tshumisano Technology Stations, focused on SMEs at the new technological universities. In 2010 the Tshumisano Technology Stations amalgamated with other six agencies to form the Technology Innovation Agency (TIA). There are indications of an existing degree of entrepreneurial and interactive capability that can create spin-off firms, as well as some government support for such initiatives. However, questions have been raised regarding the ability of spinoff companies to remain competitive over time.

Regional Development Policy:

As mentioned in Section 2.1, South Africa is divided into nine provinces. Research is highly concentrated in two: Gauteng and the Western Cape, which account for nearly 72% of all expenditures nation-wide. Structurally, these provinces have equal authority and responsibilities. However, each province implements economic development initiatives that attract investment and potential research there is not an explicit role for research policy that these regional governments are responsible. Nonetheless, indirectly research is influenced through intra-regional cluster initiatives such as the Cape IT Initiative and Blue IQ. In addition, innovation strategies such as the Gauteng Innovation Strategy have also been developed.

Involvement of private sectors in the governance bodies of HEIs and PROs

As mentioned in 3.3.2 a cross-section of stakeholders serve on the governing council of all public HEIs in South Africa. These stakeholders include private sectors leaders and representatives. Similarly, private sector representatives serve on the governing councils of South Africa’s PROs.

3.4.2 Other policy measures aiming to promote public-private knowledge transfer

Inter-sectoral mobility

Recent empirical data of the mobility of South African researchers across sectors is practically inexistent. Lack of reliable data implies the absence of a reliable way of quantifying the inflows and outflows of researchers in various sectors. A study on the mobility of R&D workers in South Africa (Kahn et al, 2004), suggested that mobility of researchers in South Africa was significant, although there is a tendency of researchers to migrate to non-R&D managerial and specialist positions in private industry and government within South Africa, in search for higher remuneration or better job conditions. The Technology for Human Resources in Industry Programme (THRIP) provides opportunities for postgraduates to work with industry while finishing their higher degrees or PhDs, opening prospects for future employment of researchers in the private sector.

Promoting research institutions - SME interactions

SEDA's Technology Transfer Division (TTD) provides significant and important incubation services aimed at the development and growth of SMEs. Services offered include: (1) Improving access to technology information by small enterprises, (2) Improving access to technology transfer funding through structured referrals to funding institutions, (3) Facilitating access to technology through business-to-business linkages, including linking inventors/ universities or science councils with small enterprise or entrepreneur with matching needs, (4) Technology consulting including development and implementation of technology audit tool, assessments of gaps in the technology deployed by small enterprises, and (5) Improving access to technology transfer funding through structured referrals to funding institutions.

Also the Technology and Human Resources for Industry Programme (THRIP) – detailed in section 2.2.1 – has effectively bridged R&D human resources in universities with industry needs by supporting R&D cooperation. According to an OECD review (2007) this programme has been recognised internationally as particularly successful when compared with similar schemes in other countries.

3.5 *Cooperation, coordination and opening up of national research programmes with the EU*

3.5.1 National participation in intergovernmental organisations and schemes

International cooperation in R&D between the EU and South Africa has expanded in recent years. The first intergovernmental agreement on Science and Technology Cooperation between South Africa and the European Union was signed in 1996, affording South African researchers the opportunity to participate fully in the EU's Framework Programmes for Research and Technology Development. Currently there are a number of initiatives in place that aim to improve South African R&D collaborations with the EU. The European South Africa Science and Technology Advancement Programme (ESASTAP) is a dedicated platform for the advancement of European - South African scientific and technological (S&T) cooperation. The relationship with the EU is one of South Africa's most strategic partnerships in international S&T relations. ESASTAP is implemented by DST and funded by the European Commission (EC). Through enhanced networking and partnering, scientists and institutions from the EU and South Africa can jointly explore new and emerging scientific and technological areas, anticipate future science and technology needs, and cooperatively seek to resolve major global issues.

The South African reciprocal agreement with the European Co-operation in Scientific and Technical Research (COST) programme is designed deepen interactions between South African and European researchers. COST will avail funding for European researchers to undertake short-term scientific missions to South Africa, whilst ESASTAP funds South African researchers undertaking such missions to Europe.

In order to support and aid potential South African Framework Programme participants, the DST has created a number of dedicated support instruments: First, the *Framework Programme Seed Funding Instrument* DST is able to supports the travel costs of South African researchers travelling to Europe to engage with European partners regarding FP7 collaboration. Alternatively funding can be granted to support the travel of European researchers to South Africa. Secondly, the *Framework Programme Strategic Co-investment Instrument*; under this instrument, successful South African FP7 participants which do not receive full funding from the European Commission for their FP7 project costs can apply for a strategic co-investment in their participation and receive funding for part of the remaining projects costs from DST. Thirdly, *the European and Developing Countries Clinical Trials Partnership* (EDCTP) Co-investment Instrument. Funding from this instrument allows South Africans to gain more insight into the relationship between health services and clinical trials with the aim of promoting synergy and ensuring sustainability of health services by participating in the European and Developing Countries Clinical Trials Partnership. Finally, the *IRSES Seed Funding Instrument* through which the DST supports South African participants in FP7 IRSES projects.

South Africa is also a partner in CAAST-Net and ERAfrica, both EC-funded projects aimed at promoting EU collaboration with Africa in the field of science and technology research for innovation and sustainable development (see section 3.5.3). South Africa has continued to provide active support to the strengthening of broader African-EU S&T partnerships through the DST's role as Vice Chair of the Joint Expert Group of the Science, Information Society and Space Partnership of the Joint Africa-EU Strategy. DST has played a central role preparing the Africa, Caribbean and Pacific (ACP) S&T Programme, which is jointly funded through the European Development Fund and the EU Development Cooperation Instrument for South Africa.

3.5.2 Bi- and multilateral RDI agreements with EU countries

South Africa also has other S&T agreements with ERA nations including: Flanders, Bulgaria, Croatia, France, Germany, Greece, Hungary, Italy, The Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Turkey and the United Kingdom. South Africa has approved joint research agreements with countries such as Poland Belgium, and Germany, with a view to aligning activities with the objectives of the Ten-Year Innovation Plan and NRDS. Innovation instruments have also been concluded between TIA and the French innovation agency OSEO. TIA signed a letter of intent with Spain's Centre for the Development of Industrial Technology in order to foster greater collaboration on innovation management. In addition, DST and the German Government are facilitating the implementation of the *Southern Africa-Germany Technology Transfer Capacity Development Programme*, under which technology transfer capacity development needs and interventions have been identified for participating countries including Botswana, Namibia, and Zambia.

3.5.3 Other instruments of cooperation and coordination between national R&D programmes

South Africa is an active partner of CAAST-Net and ERAfrica. CAAST-Net is an FP7-funded consortium of 23 African and European partners dedicated to advancing bi-regional cooperation in science and technology. ERAfrica is also an FP7-funded initiative aimed at creating a European Research Area Network (ERA-NET) for the African continent. ERAfrica unites seven EU countries (France, Germany, Belgium, Spain, Portugal, Finland and Austria), as well as Switzerland and Turkey, with three African partners (South Africa, Kenya and Egypt) in a consortium focussed on preparing new research and innovation joint activities to be funded by the partners..

South Africa is a partner in several other FP6 and FP7 programmes that encourage research cooperation at various levels and in various sectors with the aim to find solutions to problems of common interest. Some of these projects include: the European & Developing Countries Clinical Trials Partnership (EDCTP), the European Union-Developing Countries Laser Processing Initiative (EUDEVLAS), the International Cooperation in Food, Agriculture and Biotechnology (FOOD-N-CO), the EuroAfrica-ICT project, Strengthening road transport research cooperation between Europe and emerging international markets (SIMBA), the Cooperation with Europe for Life-Sciences (COEUR4LIFE) and the SAccess project, amongst many others. Additionally, DST has also its own funding instruments to promote S&T cooperation with the EU, which include a seed funding instrument to bring South African and European partners preparing FP6 proposals together, as well as a strategic co-investment instrument to afford under certain conditions "matching funding" to South African FP participants.

3.5.4 Opening up of national R&D programmes

International cooperation and leveraging of complementary resources to maximise research capacity is an important tenant of South Africa’s international STI strategy as elaborated elsewhere. These efforts are driven by the international cooperation and resources programme within the DST. While this allows for the participation of non-nationals in R&D programmes on a residency basis, these non-nationals are not eligible to participate as equity candidates even if they are from less economically developed nations or disadvantaged communities in their home country. In general, funding targets South African nationals with programmes such as the SARCHi research chairs initiative to promote world class expertise formally focuses on retaining and encouraging the repatriation of South African experts. Importantly, despite this preference most programmes are not exclusive to nationals, with expatriate researchers playing an important and growing part of South Africa’s research fabric (Kahn et al, 2004).

Typically there have not been any explicit geographical differentiation among non-nationals. While other African nationals are a significant share of the foreign expatriate researchers in South Africa, other Africans would be expected to be owing to their relative proximity. However, migration data has not been systematically collected since 2004 nor is country of origin systematically reported for nonnationality R&D programme participants, which makes it difficult to draw any strong conclusions about implicit geographical tendencies and/or biases.

3.6 *International science and technology cooperation*

3.6.1 International cooperation (beyond EU)

South Africa is committed to the broad development of nations across the continent and leveraging of global resources to achieve this development. In this regard, South Africa strives to advance the STI capabilities of other African nations. Therefore, DST actively and strategically establishes close STI cooperation with other African countries. This cooperation typically involves bilateral partnerships to promote STI for development, enhance political and economic regional integration, and encourage the mobility of scientists along with associated exchanges of information on science and technology. DST has entered into approximately 17 formal bilateral agreements with other African countries in the area of science and technology. Many of those agreements are focused within the Southern African Development Community (SADC) to promote regional integration in STI.

In addition to its African bilateral agreements, South Africa also has bilateral S&T agreements with non-Africa nations including: Argentina, Australia, Bahamas, Belarus, Cuba, India, IBSA (India, Brazil and South Africa - IBSA), Indonesia, Iran, Israel, Japan, Malaysia, Mexico, Norway, Oman, Pakistan, Peoples Republic of China, Peru, Republic of South Korea, Romania, Russia, Saudi Arabia, Spain, Switzerland, Ukraine and United States of America.

South Africa is also an active participant in AU/NEPAD S&T initiatives such as the African Mathematical Institutes Network (AMI-NET) that promotes postgraduate teaching and research in the mathematical sciences across Africa as well as the Southern Africa Network for Biosciences (SANBio) a regional network in biodiversity, biotechnology, and indigenous knowledge.

3.6.2 Mobility schemes for researchers from third countries

South Africa's HEIs have seen a marked increase in post graduate foreign students, particularly those from other African nations. According to the OECD (2009) South Africa is the 12th most preferred destination of foreign students enrolled outside of their country of citizenship, attracting 1.8% of global foreign students. The majority of the inflow of foreign students comes from African countries. This inflow has provided a natural inflow of human capital in SET for South Africa and facilitated a greater integration with the rest of the continent. However, besides bilateral agreements for R&D cooperation, there are no specific schemes designed to attract researchers from third countries. The South African Research Chairs Initiative (Sarchi) explained in section 2.2.3 is the closest to an overseas recruitment strategy. The mobility of South African researchers abroad is facilitated by a number of schemes explained in section 2.5.1. The Sarchi programme is open to non-nationals as the objective of the programme is to attract researchers living abroad. In general, research funding programmes tend to be only open to South African residents.

4 CONCLUSIONS

4.1 *Effectiveness of the knowledge triangle*

The knowledge triangle in South Africa continues to be shaped by inequality. Inequality has race, class, gender and geographic dimensions. Policy and institutional choices over the past fifteen years have given priority to a few technology platforms in high-tech sectors, while other sectors with larger socio-economic impact and larger job-generating potential are getting relatively less attention and research funding. These include the low-tech and medium-tech sectors to support manufacturing, the construction sector and the services sector. The co-existence of inequality alongside the innovation system creates a tension which must be removed if expansion of the R&D system is to significant leverage development across research, education and innovation.

South Africa's severe shortage of research skills in key areas is likely to hinder the achievement of the ambitious plans set up in the Ten-Year Innovation Plan (2008-2018), and also exposes the weak past coordination between education, research and innovation policies. Nevertheless, coordination is expected to increase with the Technology Innovation Agency (TIA), established in 2009 to improve the country's capacity to translate a greater proportion of local research and development into commercial technology products and services, bringing the knowledge from universities and public research institutions closer to industry.

Table 11: Effectiveness of knowledge triangle policies

	Recent policy changes	**Assessment of strengths and weaknesses**
Research policy	• NRDS operationalised in 2002. NSI approach to increase innovation for growth and development nationally. • Research Information Management System (RIMS) in 2008	• BERD is strong component of GERD. International niche leadership and significant diversity of capabilities, but relative stagnation over recent years. • Poor monitoring and evaluation of research inputs, outputs, processes and impact.
Innovation policy	• Ten-Year Innovation Plan launched in 2008 to guide transition toward a knowledge-based economy. • National Industrial Policy Framework (NIPF) adopted by Cabinet in 2007, containing Innovation and Technology Strategic Programme as necessary condition for industrialisation.	• Broad political support for innovation-led development and growth. However, there appears to be alignment challenges with extant innovation system. • Remaining focus on a few technology areas (high-tech) • Shortage of HRST likely to hinder the achievement of the 2018 targets set up in the Ten-Year Innovation Plan.
Education policy	• National Department of Education split into Department of Basic Education and Department of Higher Education and	• There are critical challenges to human capital development that are major constraints to South Africa's significantly increasing its innovation led growth.

	Training in 2009.	
Other policies	• Gauteng Innovation Strategy adopted in 2010 important regional innovation policy.	• Innovation is heavily concentrated geographically, creating critical clustering benefits, but also severely constraining the geography of innovation.

4.2 *Comparison with ERA 2020 objectives - a summary*

Most of the ERA 2020 objectives are addressed to some extent. Substantial efforts are being devoted to strengthen international cooperation, mobility and knowledge transfer (nationally and internationally); as well as a tendency towards increasing investments in R&D and research infrastructures. However, critical challenges remain. Governance weaknesses (such as poor cross-departmental coordination) and the huge deficit of human resources and skills continue to hamper the national research system.

Table 12: Assessment of the national policies/measures which correspond to ERA objectives

	ERA objectives	Main policy changes	Assessment of national strengths and weaknesses
1	Ensure an adequate supply of human resources for research and an open, attractive and competitive labour market for male and female researchers	• The Department of Education was split between higher education/training and basic education in 2009. • Mobility of researchers and research collaboration through ESASTAP • Human Resource Development Strategy for South Africa (HRD-SA) 2010 – 2030	• Supply of SET human capital a severe constraint to increasing R&D system • Reward for skilled SET individuals is great, but premium makes retention in R&D system difficult
2	Increase public support for research	• Increasing target of R&D within 10-Year Innovation Plan from 1% of GDP, to 1.5% by 2014 and to 2% by 2018.	• Relative share of public GERD declining • Need to systematically increase public support and coordination identified and being addressed through range of policy instruments
3	Increase coordination and integration of research funding	• Establishment of the Technology Innovation Agency (TIA) in 2009 to support R&D investment targets and associated commercialisation of outputs	• Developing institutional capacity to translate local R&D outcomes to commercial products • Significant challenges remain around inter-departmental coordination.
4	Enhance research capacity	• Overseas/bilateral Cooperation implementing new international cooperation strategy to align international relationships with both the Ten-Year Innovation Plan and NRDS since 2009.	• Leadership in partnerships across region and the continent through SADC, the AU, and NEPAD • Difficult to unify and coordinate disparate capacity of partners
5	Develop world-class research infrastructures (including e-infrastructures) and	• Initiated national strategic infrastructure programme in 2010 identifying 5 critical areas for investment through MTEF	• Rising investment in RI that is aligned to broader policy goals and targets • Accessibility often limited owing to barriers of scale and historic inequities,

	ERA objectives	Main policy changes	Assessment of national strengths and weaknesses
	ensure access to them		but transformation is slow
6	Strengthen research institutions, including notably universities	• The 2001 National Plan for Higher Education restructured institutional structure of HEIs	• Numerous funding mechanisms available to HEIs and explicit incentives for research outputs • Research and supervisory capacity of research institutions, especially HEIs, constrained by limited HCD of those institutions
7	Improve framework conditions for private investment in R&D	• R&D Tax incentives scheme of 2006 and 2009 venture capital tax incentive	• Private investment in R&D robust given level of development, but dynamism of that investment not clear despite policy incentives
8	Promote public-private cooperation and knowledge transfer	• IPR Act of 2008 adopted to enhance commercialisation of publicly funded IP and establishment of TTOs	• Growing variety of programmes to facilitate knowledge circulation and transfer • Restrictions on application of collaborative IP from new IPR Act may constrain partnerships
9	Enhance knowledge circulation	• DST overseas/bilateral cooperation programme implementing since 2009 realignment strategy to support 10-Year Innovation Strategy and NRDS	• Large and diverse cooperative agreements across the continent with considered targeted results • Different levels of development and constraints on mobility impede potential benefits
10	Strengthen international cooperation in science and technology and the role	• ESASTAP established under FP6 to enhance cooperation with the EU in S&T	• Significant and well established partnerships with EU • Numerous bilateral agreements with third countries, particularly within the SADC region.
11	Jointly design and coordinate policies across policy levels and policy areas, notably within the knowledge triangle	• Established Department of Performance Monitoring and Evaluation in 2010 to oversee and enhance impact of government across policy domains and departmental lines	• Development of integrated cross-departmental coordination evolving, still remain silos that need transformation • Several agencies tasked with ensuring S&T policies, but their impacts not broad-based
12	Develop and sustain excellence and overall quality of research	• Establishment of TIA in 2009 to support R&D investment targets and associated commercialisation of outputs	• Significant but relatively flat performance in knowledge outputs a recognised challenge for policy
13	Promote structural change and specialisation towards a more knowledge - intensive economy	• Ten-Year Innovation Plan launched in 2008 to guide transition toward a knowledge-based economy.	• South Africa's 'grand challenges' provide a road map for development, but unlocking skills constraint remains looming question
14	Mobilise research to address major societal challenges and contribute to sustainable development	• Ten-Year Innovation Plan launched in 2008 to guide transition toward a knowledge-based economy.	• Inequality remains challenge for sustainable development, the multi-dimensional manifestation of which has transformed slowly since liberation in 1994.
15	Build mutual trust between science and society and strengthen scientific evidence for	• South African Agency for Science and Technology Advancement (SAASTA) established in 2002 within NRF	• Several field specific communication initiatives focused on promoting public understanding of science, like biotechnology, nanotechnology,

	ERA objectives	Main policy changes	Assessment of national strengths and weaknesses
	policy making	to promote communication of science to the general public.	hydrogen fuel cells. • Difficulties remain in conveying some messages regarding science owing to HCD challenges

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List of Abbreviations

ACP	Africa, Caribbean and Pacific
ASSAF	Academy of Science of South Africa
AMTS	Advanced Manufacturing Technology Strategy
AU	African Union
BERD	Business Expenditures for Research and Development
BRICS	Brazil, Russia, India, China, and South Africa
CERN	European Organisation for Nuclear Research
CHE	Council on Higher Education
CIPRO	Companies and Intellectual Property Registration Office
CoE	Centres of Excellence
COFISA	Cooperative Programme on Innovation Systems between Finland and South Africa
COST	European Cooperation in Science and Technology
CPA	Consolidated Plan of Action
CSDP	Competitive Supplier Development Programme
CTP	Committee of Technikon Principals
DST	Department of Science and Technology
DTI	Department of Trade and Industry
EC	European Commission
EDCTP	European & Developing Countries Clinical Trials Partnership
ERA	European Research Area
ERA-NET	European Research Area Network
ERP Fund	European Recovery Programme Fund
ESA	European Space Agency
ESASTAP	European - South African scientific and technological Advancement Programme
ESFRI	European Strategy Forum on Research Infrastructures
FP	European Framework Programme for Research and Technology Development
EPO	European Patent Office
EU	European Union
EU-27	European Union including 27 Member States
FDI	Foreign Direct Investments
FET	Further Education and Training
FP	Framework Programme
FP7	7th Framework Programme
GBAORD	Government Budget Appropriations or Outlays on R&D
GDP	Gross Domestic Product
GERD	Gross Domestic Expenditure on R&D
GOVERD	Government Intramural Expenditure on R&D
GUF	General University Funds
HCD	Human Capital Development
HEI	Higher education institutions
HEMIS	Higher Education Management Information System

HERD	Higher Education Expenditure on R&D
HES	Higher education sector
HESA	Higher Education South Africa
HRST	Human Resource in Science and Technology
HFCT PADE	Hydrogen and Fuel Cell Technologies and Alternatives Public Awareness, Demonstration and Education
IERI	Institute for Economic Research on Innovation
IP	Intellectual Property
IPR	Intellectual Property Rights
JPO	Japanese Patent Office
MTEF	Medium Term Expenditure Framework
NACI	National Advisory Council on Innovation
NEPAD	New Partnership for African Development
NIPMO	National Intellectual Property Management Office
NRDS	National Research and Development Strategy
NRF	National Research Foundation
NSI	National System of Innovation
NSTF	National Science and Technology Forum
PEN	Public Engagement with Nanotechnology
PMG	Parliamentary Monitoring Group
PRO	Public Research Organisations
PUB	Public Understanding of Biotechnology
OECD	Organisation for Economic Co-operation and Development
R&D	Research and development
RDI	Research and Development Infrastructure
RI	Research Infrastructures
RTDI	Research Technological Development and Innovation
SAASTA	South African Agency for Science and Technology Advancement
SADC	Southern African Development Community
SAJS	South African Journal of Science
SAQA	South African Qualifications Authority
SARCHI	South African Research Chairs Initiative
SAUVCA	South African Universities Vice-Chancellors Association
SEDA	Small Enterprise Development Agency
SETI	Science, Engineering and Technology Institutional
SF	Structural Funds
SIMRAC	Safety in Mining Research Advisory Committee
SME	Small and Medium Sized Enterprise
SOE	State Owned Enterprises
S&T	Science and technology
SPII	The Support Program for Industrial Innovation
STP	Seda Technology Programme
THRIP	The Technology and Human Resources for Industry Programme
TIA	Technology Innovation Agency
TTD	Technology Transfer Division
TTF	Technology Transfer Fund
TTO	Technology transfer offices
TWAS	The Academy of Sciences for the Developing World
USPTO	United States Patent and Trademark Office
VC	Venture Capital

WIPO	World Intellectual Property Office

Annex: Expert appraisal (not to be published)

Based on the analysis performed in this report, please provide an appraisal and your expert opinion on the following issues:

I. Analyse the country situation and responses to the research-related items.

South Africa's research system is from a design perspective well positioned to increase its contribution to global knowledge generation and its relevance to socio-economic development. It has been guided in its science and technology policy by a systemic approach on 'national systems of innovation' since 1994. Complementing this approach has also been an integrated commitment to monitoring and evaluation of public sector delivery that has endured and enhanced accountability for public support of the research system. However, despite these significant enablers the research system appears to be characterised by stagnation and limited relevance to the nation's broader socio-economic needs. Research capacity in more traditional resource intensive sectors has not been leveraged to enhance development although it still continues to be a significant feature of the research environment. Despite these short-comings South Africa has made progress in the transformation of its research system so that its relevance can be tangible to the envisioned inclusive post-apartheid society. Nonetheless, it progress is vulnerable to downturn in the economies of the increasingly emerging economies of China and India.

II. Which are the impacts of the recent financial and economic crisis on the national responses? Has the role of R&D strengthen or weaken? What budget priorities R&D has to compete with and how is the debate on priorities managed? Do R&D policy makers influence the policy agenda?

The recent economic crisis has not had significant impacts other than reduced international demand from the EU and USA. However that reduction has been compensated by increased demand from China. As a result the role of R&D has remained similar to what is was before the economic crisis with GERD increasing in nominal terms but static in real Rand value. While not a product of the crisis itself job creation is the most significant challenge to R&D priorities. Current market size and increased regulatory burdens plus some question on energy provision have contributed to dampened international investments. This has been enhanced by the strong performance of resources intensive sectors that have discouraged expansion of the economy into higher value addition and thereby dampened BERD. Lastly, since 2009 the Minister of Science and Technology has been a member of the ruling party where previously all ministers since 1994 had been from other political parties. As a result, R&D policy has in recent years had increased integration with government.