Roadmap for bilateral research cooperation

The Research Council of Norway

The MeerKAT radio telescope is part of South Africa's ambitious Square Kilometre Array (SKA) project, which will be completed in 2024.

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Research cooperation with **South Africa**

The Research Council has drawn up roadmaps for cooperation with eight priority countries outside of the EU/EEU: Brazil, Canada, China, India, Japan, Russia, South Africa and the US.

The roadmaps contain background information about the research policy and the science, technology and innovation (STI) systems in the priority countries, Norway's cooperation with these countries, and an assessment of areas of and opportunities for cooperation. The roadmaps are intended to provide a basis for setting priorities and encourage more targeted cooperation with the selected countries.

The roadmaps are a follow-up of the white paper on research, Meld. St. 18 (2012–2013) Long-term perspectives – knowledge provides opportunity, which identifies these eight priority countries.

The roadmaps for international cooperation were approved by the Executive Board of the Research Council on 28 September 2014. More information about the Research Council's international cooperation is available at http://www.forskningsradet.no/en/International/1253986756029

1. Key figures and summary of conclusions

KEY FIGURES		
Population in 2012	Inhabi-tants (mill.)	51,2
Gross Domestic Product (GDP) per capita in 2012	USD (thous)	7,5
Growth in Gross Domestic Product (GDP) in 2012	Per cent	2,5

R&D EXPENDITURES		
R&D expenditures as a percentage of GDP in 2009	Per cent	0.87
Change in R&D expenditures 2002–2011	Per cent	93,6

INTERNATIONAL COOPERATION		
Joint grant proposals with Norway submitted to FP7	Number	118
Joint projects with Norway awarded funding	Number	36
Success rate of joint grant proposals with Norway in FP7	Per cent	30.5
Grant proposals submitted to FP7, total	Number	22.1
Projects awarded funding, total	Number	30.5
Success rate for South Africa in FP7	Number	2.1

TRADE AND INDUSTRY		
Import of goods and services as a percentage of GDP	Per cent	30
Norwegian goods exports to South Africa in 2012	NOK mill.	821
Norwegian goods imports from South Africa in 2012	NOK mill.	2 556
Norwegian direct capital investments in South Africa in 2011	NOK mill.	1 830
Ranking in the Global Innovation Index in 2013		58

South Africa is the leading economy on the African continent, with strong, resource-based industries and a well-established service sector. The country's STI system is far more advanced than those of the other countries on the sub-continent.

There is strong political support in South Africa for science and development, but to achieve its research objectives the country requires more modern infrastructure, modern laboratories and research institutes.

Norway and South Africa have a tradition of close ties historically, and South Africa is currently Norway's most important strategic partner in Africa. South Africa is actively involved in science and innovation at the international level. It provides a bridgehead to other countries in the region, which is of interest to Norwegian research groups and Norwegian trade and industry alike.

Both South African and Norwegian researchers have been well represented on the Intergovernmental Panel on Climate Change (IPCC). Both countries have substantial fossil fuel resources, and invest heavily in carbon capture and storage (CCS), hydrogen and solar energy, which is one of the reasons for the significant research cooperation between the countries. There is great potential for expanding this cooperation, especially cooperation within trade and industry. In this regard, both countries have identified the maritime sector as a potential focus area. South Africa's standing in Africa also provides a basis for cooperation in Norwegian interest spheres such as peace and conflict research and development research.

The areas of science, technology and innovation with special potential for cooperation between Norway and South Africa are:

- Climate and the environment
- Medicine and health
- Marine and aquatic research
- Maritime sector
- Biotechnology
- Polar and space research
- Peace and conflict research
- Development research

2. Brief description of South Africa's research policy and science, technology and innovation (STI) system

While South Africa and Norway have enjoyed close ties in the area of research cooperation through the years, they have not developed their industrial connections to the same degree. South Africa plays a key role in science, technology and innovation (STI), a rapidly growing sector in Africa, and is of strategic importance for Norway. Ties between the two countries are expected to grow stronger in the coming years. There is strong political support in South Africa for science and development, but to achieve its research objectives the country requires more modern infrastructure, modern laboratories and research institutes, as well as a national innovation system that is linked to international research circles and appropriate funding institutions.

The Science, Technology and Innovation (STI) system
South Africa is the continent's leading economy, with strong resource-based industries and strengths in services. Its innovation system has been shaped by infrastructure, assets and distortions inherited from the apartheid era. In the transition period 1990 – 1994, the gross expenditure on research and development (GERD) declined from 1.1 % to 0.7 %

as a result of the termination of key technology missions such as military dominance in the sub-continent and energy self-sufficiency. In the post-1994 era a set of policy initiatives, including policy documents such as the 1996 S&T White Paper and the Ten-Year Innovation Plan *(2008 – 2018)* were drawn up. The 1996 White Paper introduced the concept of a national system of innovation (NSI) and contributed to more than a decade of healthy increase to the GERD.

GERD accounted for 0.87% of GDP in 2009/10, which is a decrease from 0.92% recorded in 2008/09. Business expenditure on research and experimental development (BERD) decreased by 9.7%, and this had a pronounced impact on GERD. Expenditure on R&D in higher education and science councils increased by 4.3 and 1.5 percentage points respectively.

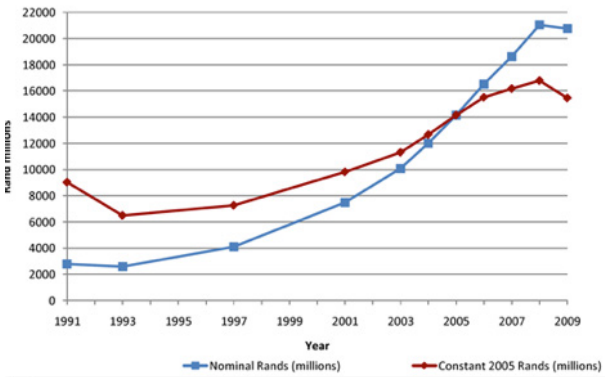
The major milestones in South Africa's STI strategy since liberation can be summarised as follows:

The Ten-Year Innovation Plan
The ten-year plan for South Africa, "Innovation Towards a Knowledge-based Economy", remains the guiding strategy document, and identifies five "grand challenges":

The "Farmer to Pharma" value chain to strengthen the bio-economy
Over the next decade South Africa South Africa aims to become a world leader in biotechnology and pharmaceuticals, based on the nation's indigenous resources and expanding knowledge base.

Space science and technology
South Africa should become a key contributor to global space science and technology, with a national space agency, a growing satellite industry and a range of innovations in the space sciences, earth observation, communications, navigation and engineering.

GROSS DOMESTIC EXPENDITURE ON R&D (GERD) (SOUTH AFRICA, 1991–2009)

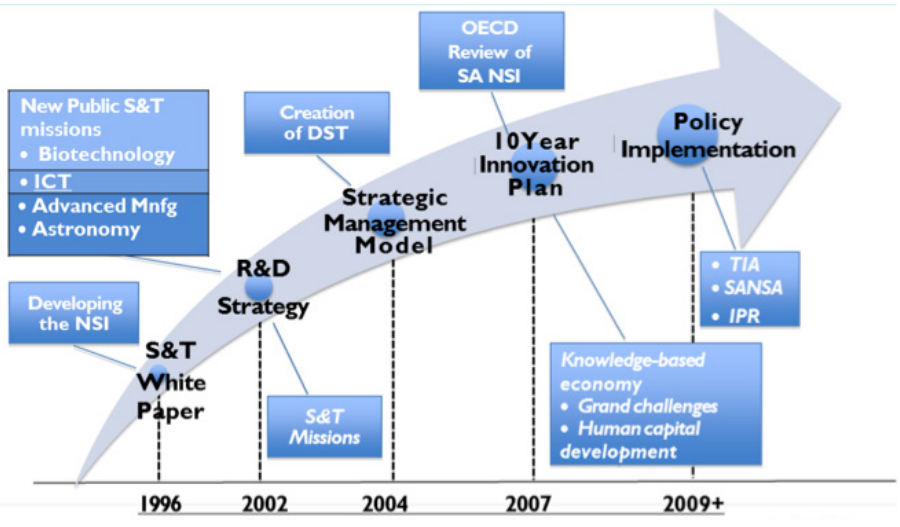


Energy security
The quest for a safe, clean, affordable and reliable energy supply; South Africa must meet its medium-term energy supply requirements while innovating for the long term in clean coal technologies, nuclear energy, renewable energy and the promise of the "hydrogen economy".

Climate research
With particular focus on global climate change. South Africa's geographic position will enable it to play a leading role in climate change science.

Human and social dynamics
As a leading voice among the developing countries, South Africa should contribute to a greater global understanding of shifting social dynamics and the role of science in stimulating growth and development.

These points reflect South Africa's technological advantages and disadvantages, such as a dependency on coal and various



MAJOR MILESTONES IN SOUTH AFRICA'S STI STRATEGY SINCE LIBERATION

social challenges. Growing attention is given to allocating public resources to address gaps in human capital and infrastructure in these areas. In addition, South Africa has adopted strategies for palaeosciences and Indigenous Knowledge Systems (IKS).

The Ten-Year Innovation Plan furthermore addresses sectorial strategies for advanced manufacturing technology strategy (AMTS), biotechnology, information and communication technology (ICT), RDI strategy and nanotechnology. The AMTS seeks to establish a vision for the manufacturing sector in 2014; it also supports priority areas of manufacturing with knowledge intensity, social equity and job creation priorities.

Part of the Ten-Year Plan is a roadmap for public research infrastructure. This is called the National Strategic Infrastructure Programme, and it 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. Cyber-infrastructure;
4. High-end infrastructure—infrastructure at the interface between research and development, and commercialisation.
5. Global infrastructure—networked international infrastructure, both single-sited and distributed.

Implementation of the Ten-Year Plan is a significant funding priority within the Department of Science and Technology (DST). Significant developments in the implementation of the Ten-Year Plan have thus far included the establishment of the Technology Innovation Agency (TIA) and the transfer of the AMTS.

Government policy making and coordination

DST is the primary agent of South Africa's research and innovation policy, but other ministries, such as the Department of Trade and Industry (DTI) and the Department of Higher Education and Training (DHET), are also important contributors, as well as other ministries with public sector research and innovation performers/agencies.
Research policy input and implementation of research policy.

Science policy advice and policy implementers

While several agencies provide advice, an important characteristic of the South African National Innovation System (NIS) is that no high-level body advises the government as a whole on R&D and innovation policy. Key agencies currently providing policy advice include the following:

- The National Advisory Council on Innovation (NACI)
- The Academy of Science of South Africa (ASSAF)
- The National Science and Technology Forum (NSTF)

Public research organisations (PROs) are important to the South African research system. Foremost is the National Research Foundation (NRF), which is responsible for promoting and supporting basic and applied research as well as innovation. The NRF provides services and grants to support research and postgraduate research training, and it is governed by an independent board that is appointed by the Minister of Science and Technology. The NRF is also responsible for the seven Centres of Excellence in the country. Through the Technology and Human Resources for Industry Programme (THRIP), the NRF funds research together with the DTI.

Young researchers at the Applied Centre for Climate and Earth System Science (ACCESS) in Cape Town.

Another important agency targeted for industrial research is the Technology Innovation Agency_ (TIA), which became operational in 2011. It provides financial support to the NIS using a host of financial support instruments. Other PROs include:

- The Medical Research Council (MRC)
- The Africa Institute of South Africa (AISA)
- The Agricultural Research Council (ARC)
- The Council for Scientific and Industrial Research (CSIR)
- The Council for Geosciences (CGS)
- The Human Sciences Research Council (HSRC)
- The Council for Mineral Technology (Mintek)
- The South African Bureau of Standards (SABS)

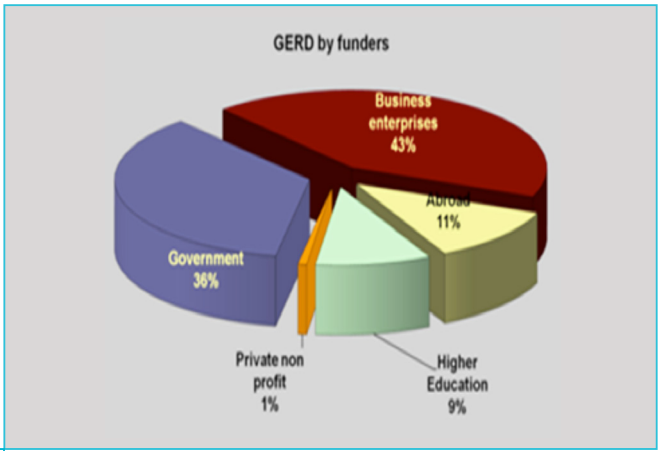
In order to nurture a new generation of researchers and to address skills shortages, a series of initiatives have been undertaken, including schemes for women and for the black community (e.g., The Thuthuka Programme). Targeted financial support to researchers has helped mitigate brain drain (e.g. South African Research Chairs Initiative (SARChI).

A programme that ought to be of particular interest to Norway is the South African National Antarctic Programme (SANAP), which includes the SANAE IV research station and an entirely new polar research vessel named SA_Agulhas_II.

Scientific production

The bulk of South Africa's research is conducted in universities, and scientific publication is essentially their business, and particularly the business of the 'big five' (the universities of Cape Town, Witwatersrand, KwaZulu-Natal, Pretoria and Stellenbosch). These universities accounted for 69% of citations (roughly 4,000 each). A second tier comprises Rhodes (1,250), Free State (1,127), North West (929) and Western Cape (920). Beyond the universities, the Medical Research Council and the CSIR produced 871 and 429 publications respectively.

RESEARCH FUNDING SOURCES BY SECTOR, 2009–2010



Funding flows

In the 2009 fiscal year, the total gross domestic expenditure on research and development (GERD) came to EUR 1 756 million, distributed among the funding sources shown in the figure.

The business enterprise sector

The business enterprise sector is the largest actor within science and development in South Africa. Business expenditure on research and experiment development (BERD) came to EUR 1 023 million in the 2009 fiscal year. Companies themselves funded 72 % of this research. BERD accounted for 59 % of GERD. Experimental development activity represented 64 per cent of BERD, while applied research and basic research comprised 28 per cent and 9 per cent, respectively. Natural science, technology and engineering represented 97 % of BERD. Since 2007–2008, there has been a fairly sharp decline in BERD, resulting in a general decrease in the overall GERD.

3. South Africa's STI strengths and weaknesses and the country's international standing

Strengths

South Africa has a relatively high level of activity in fields related to natural resources – ecology/environment, geo-sciences, plant and animal science, and agricultural research. However, South Africa's level of impact remains under the global average.

Only immunology has both an activity level and an impact level around the global average. This can be understood in light of the great need for research in the field of HIV/Aids. This is likely due to the high need for research in the field of HIV/AIDS. There is also a high activity level in space sciences, education, social sciences, psychology/psychiatry and economics/ business, as well as an achieved impact in mathematics— despite a relatively low level of activity.

South Africa's investment in science and technology is far from ideal, but given the country's enormous social challenges (poverty, unemployment, etc.), most of the country's resources are thinly spread. There is, however, strong political support for science and development as well as growing recognition of the roles science can play in solving some of these challenges. In order for South Africa to succeed in meeting its scientific objectives, it will need to develop state-of-the-art infrastructure, modern laboratories and research institutes, and a national system of innovation linked to the global scientific community and appropriate funding agencies. This will also require maximisation of existing international collaboration. South Africa has clearly benefited from such collaboration in the post-apartheid area, increasing its scientific output considerably.

Web of Science data show a strong increase in the volume of publications, although the number of researchers has remained about the same. In 2004–2008 the total number of publications was 33 671, compared with 20 892 in 1990–1994. The fact box below shows a summary of results and trends measured in terms of the number of scientific publications. The box below gives a summary of the outputs and trends in scientific publications, which correspond well with the findings in the bibliometric study commissioned by RCN (the Science-Metrix study):

SOUTH AFRICAN-AUTHORED WEB OF SCIENCE ARTICLE COUNTS 1990/94 AND 2004/08 (FROM KAHN (2011): A BIBLIOMETRIC ANALYSIS OF SOUTH AFRICA'S SCIENTIFIC OUTPUTS)

Article **counts** rose by 60% from 20,892 to 33,671.

Subject areas of continued focus: Ecology (1, 5), Plant Sciences (2, 2), Zoology (3, 3), Biochemistry & Molecular Biology (6, 7) and Astronomy (10, 10). [The first digit is the 2004-08 rank; the second is for 1990-1994].

New subject areas: Environmental Sciences (4, 16), Public and Environmental Health (5, 25), Infectious Diseases (7, 83) and Biotechnology and Applied Microbiology (9, 23).

Subject areas in decline: Medicine, General and Internal (16, 1) and Surgery (29, 4)

Co-publications unadjusted for multiple authorship rose from 4% to 21% of all publications.

Foreign co-publication increased sharply, especially in the Health Sciences. Publication remains concentrated in the universities, especially UCT, Wits, Kwazulu-Natal, Pretoria and Stellenbosch, which account for 69% of the total (double counts included). Publications stagnated in the **state sector.**

Private sector publications remain few in number and are now confined to SASOL and the Sugar Industries Research Institute.

The Benguela goby, a subject of Norwegian-South Africa research.

The Ten-Year Innovation Plan set targets for two indicators that are central to scientific production: South Africa's global share of research outputs (0.5 per cent in 2002) should reach 1 per cent, while the number of full-time equivalent researchers (11,439 in 2005) should rise to 20,000 by 2018.

Weaknesses

DST identifies some major weaknesses in the national system of innovation that may put constraints on future expansion. Foremost is the inadequate renewal and expansion of human resources in S&T, which has also been pointed out by in reports by the OECD and other outside observers. Although the share of total enrolment of S&T majors (including health sciences) has shown a slight increase (from 29% in 2005 to 30% in 2008), the system now faces the problem of an ageing core of (mostly white male) scientists, which is a problem shared by bench-mark OECD member countries.

DST also points out the continued underrepresentation of black and female post-graduate students and researchers, though the percentage of female researchers (40%) is actually significantly higher than in most OECD countries, Norway included. Another problem is low completion and graduation rates, especially at the post-graduate level, of students from the historically disadvantaged groups. This is linked to the cost of prolonged studies, inadequate bursaries and the obligation of such students to provide financial assistance to their families. Other constraints include

- Inadequate legislation on intellectual property rights;
- Fragmented governance structures;
- Inadequate STI infrastructure; and
- Reduced levels of local investment in R&D by the private sector.

On the other hand, South Africa is self-conscious about its own weaknesses and is therefore putting considerable effort into improving its STI system and into showing progress in a number of areas. The UNESCO Institute for Statistics recently conducted a pilot study based on innovation statistics from nine countries. The study shows that South Africa compares quite favourably to the other countries included in the study, including the other BRICS countries except for India. The report focused exclusively on data about the manufacturing industry that could be compared across national borders, and it showed that China and South Africa took turns as the country with the highest share of companies carrying out innovation activity in the manufacturing industry.

4. Current cooperation with South Africa

Multilateral cooperation

After being virtually isolated from the rest of the world during the apartheid years, South Africa has put a lot of effort into playing an increased role in the international arena, not least when it comes to international STI cooperation. Such collaboration is, to a large extent, centred on South Africa's participation in the EU's Framework Programmes, which dates from the signing of an agreement on S&T cooperation between the EU and South Africa in 1996.

Since 1996, South Africa has taken part in almost 500 research projects worth approximately EUR 25 million, including in the following priority areas: health, food, agriculture and biotechnology, information and communication technology, the environment (including climate change), socio-economic sciences and the humanities, transport and aeronautics, research infrastructures, international cooperation, researcher mobility (the Marie Curie International Research Staff Exchange Scheme), nuclear fission and radiation protection (European Atomic Energy Community – EURATOM), nanoscience, nano-technology, materials and new production technology, Small and Medium-sized Enterprises, and Science in Society.

Under the EU Seventh Framework Programme (FP7), South Africa is ranked fifth among the active third countries, after Russia, the US, China and India. An important milestone in EU-South Africa cooperation has been the establishment of a dedicated platform for advancement of the European–South African Science and Technology Advancement Programme (ESASTAP) in 2005. This project was renewed under the label ESASTAP Plus in November 2012 and aims to enhance cooperation by fostering the participation of South African researchers in EU-funded projects and providing for reciprocal arrangements for European scientists. It also seeks to develop new joint science and technology initiatives. Some of the FP7 projects with South African participation include

- *European & Developing Countries Clinical Trials Partnership (EDCTP)*
- *European Research Infrastructures Network of National Contact Points (EuroRIs-Net)*
- *European-South African Research Cooperation in Aeronautics and Air Transport (AeroAfrica-EU)*
- *The EuroAfrica-ICT project*
- *The SAccess project, designed to increase the participation of European researchers in South African innovation programmes.*
- *Strengthening Road Transport Research Cooperation between Europe and Emerging International Markets (SIMBA)*
- *Science and Technology-Europe Africa Project (ST-EAP)*
- *Regional Impact of Information Society Technologies in Africa (IST-AFRICA)*

Another major feature of the ERA partnership with South Africa is a €30m sector budget support programme to the DST, which was provided under the EU Development Cooperation Instrument for South Africa. This programme is the first of its kind to aim to harness science and technology for growth and development, especially poverty alleviation. The South African reciprocal agreement with the European Cooperation in Scientific and Technical Research (COST) programme is designed to deepen interactions between South African and European researchers. COST will provide funding for European researchers to undertake short-term research projects in South Africa, whilst ESASTAP funds South African researchers doing the same in Europe.

South Africa actively supports efforts to achieve broader STI cooperation between Africa and the EU through the role of DST as the vice chair of the Joint Expert Group of the Science, Information Society and Space Partnership of the Joint Africa-EU Strategy. The department has played a critical role in the establishment of the African, Caribbean and Pacific (ACP) Science and Technology Programme, which is funded by the European Union.

South Africa is part of ERAfrica, which aims to create a European Research Area Network (ERA-NET) for the African continent. South Africa has also been an active partner of CAAST-Net and, as of 2013, CAAST-NET_Plus, which is an FP7-funded consortium of 26 African and European partners dedicated to advancing bi-regional cooperation in science and technology.

In 2014, South Africa achieved associate membership in the EUREKA network. At the same time, Norway, represented by RCN, chaired the network. The country had already signed bilateral S&T agreements with 20 EUREKA member countries, including Norway.

South Africa is also, together with Norway and several other countries, an active member of both the Belmont Forum and IIASA (International Institute for Applied Sciences).

Bilateral cooperation

Norway's cooperation with South Africa on research and higher education dates back to the apartheid period when Norway, together with other Nordic countries, provided support to South Africans who had been forced into exile, as well as to children and relatives of imprisoned anti-apartheid activists.

After liberation in 1994, a number of cooperation initiatives within higher education and research were initiated, especially through the NUFU-Programme, which was administered by the Norwegian Centre for International Cooperation in Education (SIU), but also through programmes specifically targeting South Africa, such as the SANTED programme. The first programme aimed solely at research cooperation started in 2002 and went through two phases until 2011, with a total financial frame of about NOK 80 mill., out of which more than ZAR 12 mill. were provided by the DST. The programme supported a total of 67 joint projects. In February 2013, a new research cooperation programme for research relating to climate change, the environment and clean energy (SANCOOP) was initiated, resulting in the support of 19 bilateral projects.

On a higher political level, there have been frequent high-level meetings between the two countries' ministers responsible for research and higher education. Eight such visits have been conducted since 1999. As part of this process, in May 2002 Norway and South Africa signed an agreement on research

	Norway	Sweden	Denmark	Finland
USA	0.82	0.91	0.89	0.75
UK	1.19	1.20	1.28	1.04
Germany	0.98	1.16	1.18	1.01
France	0.92	0.92	0.95	0.85
China	0.54	0.73	0.57	0.58
Russia	1.05	0.97	0.60	1.83
Japan	0.62	0.71	0.57	0.75
South Africa	1.54	1.04	0.86	0.48
Brasil	0.59	0.59	0.61	0.70
India		0.65		0.81
Norway		3.49	3.56	2.28
Sweden	3.49		3.00	2.91
Denmark	3.56	3.00		2.02
Finland	2.28	2.91	2.02	

RELATIVE COOPERATION INDEX BETWEEN NORWAY AND SOUTH AFRICA VIEWED IN RELATION TO THE COOPERATION INDEXES OF THE OTHER NORDIC COUNTRIES.

Source: Norwegian Ministry of Education and Research

FP7: RESULTS PER THIRD COUNTRY								
Research cooperation with EU, FP7	Brazil	Canada	India	Japan	Kina	Russia	South Africa	USA
Number of joint grant proposals with Norway	101	108	83	49	166	238	118	241
Number of approved projects with Norway	26	38	18	21	37	64	36	62
Success rate of joint grant proposals	25.7 %	35.2 %	21.7 %	42.9 %	22.3 %	26.9 %	30.5 %	25.7 %
Number of grant proposals, total	1 146	919	1 036	423	1 398	1 944	887	4 138
Number of approved projects, total	175	166	170	108	245	323	196	528
Success rate, total	15.3 %	18.1 %	16.4 %	25.5 %	17.5 %	16.6 %	22.1 %	12.8 %

Data source: EU's E-CORDA database

cooperation, which is still in force today. These close relations, together with the aforementioned bilateral agreements, appear to have laid the foundation for a remarkably high rate of research collaboration between Norwegian and South African researchers.

As the table shows, only the Nordic countries have a higher cooperation index for Norway when adjusted for size.

Several Norwegian institutions have their own bilateral agreements with institutions in South Africa. Some are members of the Southern African-Nordic Centre (SANORD), a partnership of 42 higher education institutions in the Nordic countries and the countries comprising the Southern African Development Community. SANORD is based at the University of the Western Cape.

Other agreements are between Norwegian and sister institutes in South Africa only. South Africa is third after the USA and China when it comes to the number of bilateral agreements between Norwegian research institutions and institutions abroad. One of the bilateral institutional agreements is the contract for the implementation of the research cooperation agreement between RCN and NRF.

As citizens of a BRICS country, South African students and scientists are eligible to participate in UTFORSK, a new Norwegian instrument for strengthening the linkage between higher education and research in international collaboration, and for increasing cooperation between Norway and the BRICS countries. The programme is administered jointly by RCN and SIU. A strategy on the BRICS countries is currently being prepared by the Norwegian Ministry of Education and Research.

Norwegian and South African researchers are also collaborating extensively in the multilateral arena, particularly within the EU framework programmes. Under FP7, South Africa and Norway participated in 118 joint applications, resulting in the approval of 36 projects. The success rate was 30.5 %, considerably higher than the average success rates for the two countries and the average for *all* of the countries in FP7.

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The Science-Metrix study referred to in section 3 confirms the high collaboration rate is of high quality. Of the seven non-EU members with whom Norway co-publishes *more* than expected, South Africa has the highest collaboration (1.83). South Africa's collaboration rate with Norway (0.19%) is also more than twice the global average of 0.08 %.

5. Justification for considering cooperation with South Africa

The Research Council of Norway's Strategy for International Cooperation 2010–2020 identifies five main objectives for increasing international cooperation, and close ties with South Africa can contribute particularly to achieving three of these:

- Help to address global challenges to society;
- Enhance the quality and capacity of Norwegian research;
- Secure Norway access to international knowledge production.

South Africa has by far the most advanced STI system in sub-Saharan Africa (SSA), where the country is regarded as an economic superpower. Most of the leading universities on the African continent are located in South Africa, and some of these achieve high rankings internationally. South Africa is also the largest economy on the continent, despite ranking only fifth in population size.

Historically the populations of the two countries have close ties, even during the apartheid period, when Norway provided considerable support to the anti-apartheid movement. Today, South Africa is Norway's principal strategic partner in Africa.

The past decade has seen steady growth in research cooperation between the two countries. Of the non-EU countries, only Russia, China and Australia have more cooperative projects with Norway under FP7 than South Africa. Researchers in the two countries should be encouraged to follow up the good success rate on their joint grant proposals for FP7 by submitting joint grant proposals to programmes under Horizon2020 programmes.. The results from FP7 show that ties between the two countries in science and technology are favourable for Norway and mutually beneficial for both countries. A good basis for future cooperation is the ESASTAP Plus programme, mentioned in section 4 above.

The two other objectives for international cooperation identified in RCN's Strategy for International Cooperation are related more to strengthening Norwegian industry and innovation, where South Africa's role is somewhat more uncertain, at least in the short term. Industrial relations between the two countries remain at a modest level, despite certain similarities between the countries' economies, in that both are highly dependent on the extractive industry. However, research cooperation may open the door for expanded cooperation within the private sector, and the same may prove true for South Africa's associated membership of EUREKA, which was approved during Norway's chairmanship in 2014. Some Norwegian companies have already increased their focus on South Africa, such as Scatec_Solar which opened Africa's largest solar energy plant in Kalkbult, Northern Cape, in November 2013. From the South African side, the state-owned energy company Sasol has invested in the Mongstad Technology Centre for carbon capture.

From the Scatec Solar plant in Kalkbult.

Both countries can take advantage of their geographic positions to increase cooperation on polar research. Norway is the gateway to the Arctic, whereas South Africa is the gateway to the Antarctic.

6. Current priorities for Norway's activities vis-à-vis South Africa

South Africa is one of the eight priority cooperation countries outside the EU explicitly mentioned in Norway's last white paper on research (2013), as it has been in the previous two white papers. In 2002, a general S&T agreement was signed between the two countries, and three bilateral research cooperation programmes, following framework agreements signed in 2001, 2006 and 2013, have contributed significantly to this S&T cooperation.

Sixty-seven collaborative projects based on an equal partnership were funded through the first two programmes, which resulted in a large number of high-quality scientific publications in prestigious scientific journals, including "Science". The third bilateral programme, the Programme for South Africa-Norway Research Cooperation on Climate Change, the Environment and Clean Energy (SANCOOP), issued a funding announcement in 2013 with a budget of NOK 47 million and funded 19 new projects as from 2014.

In addition, the Research Council cooperates with South Africa on individual FP7 initiatives. These include the STI International Cooperation Network for Eastern Partnership Countries (Inco-Net), the Science, Technology and Innovation Cooperation between Sub-Saharan Africa and Europe (CAAST-NET_Plus), and the ERA-net ERAfrica (the latter two are mentioned in section 2 above).

High-level talks between South Africa and Norway held in Oslo in November 2013 confirmed the strong ties between the two countries and concluded that cooperation should be expanded into new areas, especially the maritime sector, trade and value creation.

7. Follow-up and implications

The bibliometric study of 2014 confirms South Africa's active involvement in international research and innovation. The country's relative cooperation index is among the very highest in the world, and in recent years, it has risen above the world average when it comes to «scientific impact». Furthermore, multinational projects with participation by South African researchers have a high success rate for grant proposals submitted to EU-funded calls.

The SANCOOP agreement is signed by Deputy Director General of Research, Development and Innovation under the South African Department of Science and Technology Mmboneni Muofhe and Norway's Ambassador to South Africa Kari Bjørnsgaard, February 2013.

This gives Norwegian actors wide-ranging opportunities to expand their research cooperation with South Africa. At the same time, South Africa's broad-based focus on internationalisation also means that Norway will be competing with leading research nations such as Germany, France and the UK in Europe, as well as with other countries around the globe, especially in Asia, and China particular. Norway's advantages in this context, however, include the strong historical ties between the two countries, especially within research and higher education.

The high-level bilateral talks in November 2013 between Norway and South Africa underscored the desire on the part of both countries to continue their research cooperation. South Africa also serves as a bridgehead in to other countries in the region, especially within the South African Development Community (SADC), which should of interest to the Norwegian research community and trade and industry.

Priority research areas

Climate and the environment

This is currently Norway's main priority area for research cooperation, addressed in part through the Programme for South Africa-Norway Research Cooperation on Climate Change, the Environment and Clean Energy (SANCOOP) funded by the Norwegian Ministry of Foreign Affairs. It is in this research area that the most cited co-publications between South African and Norwegian researchers are found. Both countries have dynamic research groups in different areas of environmental research – South Africa focuses in particular on biodiversity – and within climate research both countries have been well-represented on the Intergovernmental Panel on Climate Change (IPCC). Climate systems and the social impacts of climate change are important common denominators here.

Energy

Both countries have vast fossil fuel resources. In South Africa this is primarily coal, on which the country depends for electricity production and fuel production for the transport sector, resulting in large CO_2 emissions. Both countries invest heavily in carbon capture and storage (CCS). Norway has provided support for a pilot project on CO_2 storage in South Africa; the Norwegian Ministry of Petroleum and Energy serves as the contact ministry for this project. South Africa is concerned with developing alternative, renewable energy sources and puts special emphasis on research on hydrogen and solar energy.

Medicine and health

This was a priority research area in previous bilateral cooperation programmes and helped to generate extensive research cooperation in addition to individual institutional agreements that date back a number of years. Moreover, Norwegian and South African researchers cooperate extensively through the European and Developing Countries Clinical Trials Partnership (EDCTP). Several of the health research communities in Norway are interested in increasing cooperation with South Africa in the areas of health and welfare, and medical technology.

Marine and other aquatic research

This has been one of Norway's main focus areas, and some cooperation is still ongoing, such as through the Nansen-Tutu Centre in the area of marine ecology and other individual projects. The potential to increase cooperation on marine research is great, partly in connection with the new NANSEN-programme, planned to be launched in 2016.

Technology

In relation to Norway's other priority countries, the Norwegian technology bastions are represented relatively modestly in the number of co-publications with South Africa and the citation index. This may be due in part to the moderate level of involvement of the Norwegian business enterprise sector in South Africa. However, there are considerable opportunities in the long term for this sector to increase its involvement, especially in the area of biotechnology, in which South Africa invests heavily. In addition, both countries have strong extractive industries, and cooperation on environmental and energy technologies and on metal production are potential areas for cooperation.

Polar and space research

Polar research is a traditional area of cooperation between the two countries, not least with regard to Antarctica, including Bouvet Island. South Africa has a research station which is the closest neighbour of Norway's Troll research station, as well as a top-modern polar research vessel that may be used for various research voyages. Space research in South Africa has blossomed after the country was selected as one of the sites for the Square Kilometre Array (SKA) project. Both Norway and South Africa are very active users of satellites for earth observations through the Norwegian Space Centre and the South African National Space Agency (SANSA), especially in the polar regions.

Social science and humanities research
Over the years Norwegian researchers in the social sciences and humanities have enjoyed close cooperation with their South African colleagues, although they have not centred their efforts on any particular research themes. The initiative on climate and environmental research is expected to result in more activity related to adaptation to changes in the climate and environment. This should not, however, lead to less focus on areas with a longstanding tradition of high-quality collaboration, such as archaeology, linguistics, culture, history, etc. Norway's political cooperation in several peace processes will also be of interest to Norwegian peace and conflict researchers, and South Africa's unique position as a bridgehead in to the rest of the continent is relevant to Norwegian development researchers.

Maritime sector
Although the maritime sector has not been an area of research cooperation thus far, it is now high on the political agenda in both countries. There is great potential to link innovation-oriented research with an anticipated increase in industrial cooperation.

Innovation, industrial development and commercialisation of R&D
In order for actors in the Norwegian business enterprise sector to achieve the results they are seeking, South Africa must develop local networks that ideally will involve both local companies and local research groups, especially through the Council for Scientific and Industrial Research (CSIR) in South Africa, which may be compared to the Norwegian research organisation SINTEF.

The government of South Africa are very concerned with developing a national innovation system, and have established a number of instruments to encourage more innovation. With a few notable exceptions, Norwegian businesses have not taken full advantage of this. However, South Africa's associated membership of EUREKA is expected to encourage the creation of more ties between Norwegian and South African SMEs. Among the larger companies, Sasol in particular, South Africa's largest energy company, already has close ties with Norway and has, among other things, become a partner in the Mongstad Technology Centre.

The industry areas that appear to have the greatest potential, in part due research cooperation priorities and the high-level talks between the two countries, are the following:
- Climate-related technology, especially CCS
- Renewable energy, especially solar power and hydrogen-based energies
- The maritime sector
- Aquaculture
- Environmental solutions, especially water management

Instruments
In the coming years the Research Council will give high priority to the new bilateral SANCOOP programme (2013–2017), in cooperation with the Norwegian Ministry of Foreign Affairs. The Research Council, together with the Norwegian Ministry of Education and Research, is expected to continue to play a key role in the follow-up of the state-to-state agreement on science cooperation from 2002, e.g. by organising meeting places for researchers who work with topics that both countries give priority.

South Africa has great ambitions when it comes to its participation in Horizon2020. The high success rates shown in FP7, partly in cooperation with Norwegian researchers, should encourage more partnerships in applications to coming EU calls.

Both countries' intense focus on environmental and climate research should result in greater cooperation in the Belmont Forum, in part through the Future Earth initiative. The National Research Foundation represents South Africa in the forum, while the Research Council of Norway represents Norway. In addition, both countries are active members of the International Institute for Applied Systems Analysis (IIASA), which should open up the opportunity for joint initiatives between the two countries' researchers through this institution.

Although many Norwegian and South African institutions have already signed separate cooperation agreements, the long-term international institutional partnership scheme that will be administered by RCN and SIU may emerge as an instrument for consolidating existing agreements and generating new ones. The upcoming BRICS strategy announced by the Norwegian Ministry of Education and Research will include long-term institutional cooperation in addition to instruments designed to increase the number of Norwegian students in these countries.

Norwegian business enterprises should take advantage of South Africa's associated membership of EUREKA, which will allow Norwegian companies to invest in South Africa and gain access to its markets. Norwegian companies may apply for funding to establish operations in South Africa from the Norwegian Investment Fund for Developing Countries (NORFUND) and Innovation Norway's scheme for industrial research and development contracts.

Both companies and research groups in Norway with an interest in South Africa should familiarise themselves with the ESASTAP Plus portal, which provides updated information on funding announcements involving South African participants, "twinning projects" and stimulation measures for research and innovation in South Africa.

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