Department of Science and Technology

A National Key Research and Technology Infrastructure Strategy

Abridged Version

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National Research Foundation

A NATIONAL RESEARCH AND TECHNOLOGY INFRASTRUCTURE STRATEGY

ABRIDGED VERSION

1. Introduction

Our nation's mission to create wealth and thereby to create jobs and eradicate poverty hinges largely on our ability to develop new products, technologies and services through research and innovation. This can only be achieved in a highly competitive world if the nation has at its disposal the required human capital capable of generating new knowledge and technologies through research in an environment with quality infrastructure that includes state-of-the-art research equipment. The maintenance of state-of-the-art research equipment and infrastructure linked to the development of highly skilled people and the generation of knew knowledge and technologies, is globally recognised as being a core responsibility of the state, and hence the funding of research equipment, particularly in higher education and the science councils, should primarily be from public funds.

The National Research and Technology Audit of 1998 identified our equipment infrastructure for research and technology development as being old, and not enabling South African researchers to compete effectively internationally. On the basis of this audit it is estimated that the present day replacement value of our research equipment infrastructure is R3.7 billion, and that only 10% of this can be regarded as being state-of-the-art. This state of the country's research and technology infrastructure was highlighted in the Cabinet approved National Research and Development Strategy of 2002, as well as the urgency of a major intervention in the renewal thereof. Hence, this National Key Research and Technology Infrastructure Strategy has been developed in response to and in support of the National Research and Development Strategy.

This document is an abridged version of the extended strategy document which is attached as an Appendix. Reference is therefore made under the various headings below to the chapters in the expanded text for further information where required.

2. Context and Background of the Strategy

No coherent national strategy for the renewal and placement of research equipment exists. Funding of research equipment was done much on an ad hoc basis, with the National Research Foundation (NRF) and its predecessor the Foundation for Research Development (FRD) having funded and placed some equipment in higher education in a loosely coordinated manner to ensure some means of regional accessibility and capacity building. In more recent years, several policy instruments of government are making provision for the placement of some research equipment, albeit within the confines of these instruments, e.g. the Innovation Fund, THRIP and the Biotechnology Strategy. Industry, NGOs and Trusts have also contributed to the placement of research equipment, particularly in higher education. All of this falls way short of what is required to maintain the research equipment infrastructure necessary to produce cutting edge research to remain internationally competitive in science and technology and thereby to meet the growth and development needs of the nation (Chapter 2).

The under-equipped and ageing nature of equipment in South African universities was already highlighted in a review of research equipment undertaken in 1992, and re-emphasised in the National Research and Technology Audit of 1998. The audit emphasised that only 10 % of the country's equipment base at the time could be considered as state-of-the-art, i.e. less than five years of age. Given the funding trends of equipment over the past six years, this situation has not changed much. On this basis it is estimated that the present day replacement value of the research equipment infrastructure is R3.7 billion, and that still only 10% of this can be regarded as being state-of-the-art, with the remainder being outdated to a large extent.

A macro-environmental scan was conducted where the strategies, policies and funding methodologies in selected countries were researched to establish their approach to research facility and equipment management and support. This scan was followed by an analysis of the strategy and policy environment in South Africa that influences the development of a National Key Research and Technology Infrastructure Strategy. Particularly relevant in this regard are the National Research and Development Strategy, the technology driven strategies such as e.g. the National Biotechnology Strategy for South Africa and the Advanced Manufacturing Technology Strategy, the Integrated Manufacturing Strategy, and the New Framework for Funding of Higher Education (Chapters 2 and 3)

3. Strategic objectives (Chapter 4)

This equipment strategy focuses specifically on those research and development objectives which can be assigned directly to the public good, i.e. research targeted by government, research for the purpose of developing our high level human capital and research for the purpose of the proliferation of new knowledge. It excludes research in response to market demand inasmuch as this is being pursued by the private sector. The strategic objectives are therefore defined as follows:

- Prioritising types of research equipment and the purpose of such equipment
- Differentiating between categories of research equipment for planning and funding purposes
- Creating a long range planning culture around research equipment
- Assigning responsibilities for the funding and management of research equipment
- Establish guidelines for economic models required to sustain the research infrastructure
- Introducing proper quality management of research equipment
- Identifying appropriate funding levels for re-capitalisation of equipment infrastructure
- Ensuring optimal use of world-class research equipment in a sustained manner
- Assuring access to research equipment by providing grant funding for mobility of researchers

4. Scenarios for the development of a strategy

Scenarios were generated for the South African research infrastructure renewal strategy (Chapter 5). The scenarios allow for possible outcomes in terms of:

- **Local Focus:** Research aimed at primarily solving local priorities and demands. The context of "local" is national (as in South Africa) and may be extended to include sub-regional (as in SADC)
- **Global Focus:** Research aimed at making South African industry and knowledge globally competitive

This is viewed from strategic options that can be exercised in the placement and management of research infrastructure, viz.:

- **Well-found Laboratory:** minimum level of (usually departmental) equipment and facilities that an external sponsor of quality research would expect to find in place
- **Infrastructure for world-class science:** major items of equipment for multi and interdisciplinary research which are usually too costly to acquire by institutions individually or collectively.

The preferred scenario of a strategy is to strengthen both the well-found laboratory and to re-capitalise the equipment infrastructure to conduct world-class science simultaneously. This dual approach is required since the installed base of equipment has aged considerably and very little attention has been given in many institutions, particularly higher education, in maintaining and modernising the well-found laboratory environment.

5. Strategic framework following from the scenario (Chapter 6)

The acquisition and placement of key research equipment must happen within a policy framework that addresses national and regional needs and priorities. Within this strategic framework, competitive world class research relies on a spectrum of state-of-the-art research equipment, which varies from low-cost, dedicated bench-top laboratory equipment characteristic of the well-found laboratory, to large, expensive research facilities with scientific, technical and administrative support staff with annual budgets of several tens of millions of Rand.

A strategic framework for key research and technology infrastructure must of necessity have a holistic approach to the entire spectrum of research infrastructure needs. It must furthermore also take cognisance of the more recent initiatives to implement policy in line with the national strategies referred to above, which make provision for the acquisition and placement of state-of-the-art research equipment such as the Innovation Fund, the Biotechnology Strategy, THRIP and Centres of Excellence. There are however some limitations of the extent to which these strategic initiatives meet the equipment infrastructure requirements of the nation, viz.:

- Limitations in the grant size and hence limitations in the type of equipment that can be acquired within the context of these strategies
- The dedicated nature of the equipment, i.e. very project specific and hence often focused on departmental level within higher education.

Given the wide spectrum of research equipment, six **categories of research equipment** are identified, clustered into three broader categories for the purpose of developing a strategy

- Equipment of the **well-found laboratory**, generally used by one or several researchers and students within a department and funded by the institution from own funds or the researcher from his/her research grant.
- **World-class, multi-user equipment**, consisting of
    - Multi-user within institutional context, i.e. part of the institutional research infrastructure utilised by researchers from several disciplines and departments
    - Multi-user in regional or national context includes expensive research equipment which is normally beyond the means of a single or cluster of institutions. Depending on needs, equipment of this nature may be placed in several regions to serve the needs of researchers within the region, or where only one piece is available in the country to serve the needs of researchers in the country.

- **Big, expensive facilities**
  - **National Facilities**, Includes research facilities which normally require a high capital investment and a substantial annual budget of several tens of millions of Rand to manage and maintain. Facilities of this nature are structured around unique research equipment or collections. Two types of national research facilities can be distinguished, viz.:
    - Declared National Research Facilities, are those that are managed by the NRF with the aid of an entrenched budget earmarked for such facilities.
    - Facilities hosted by other institutions, such as the National Laser Centre, the Satellite Applications Centre, and the SAFARI nuclear reactor.
  - **International Facilities:** Mega-science facilities located in South Africa by virtue of e.g. geographical advantage in which South Africa has acquired a share on behalf of local users such as SALT, SKA
  - **Foundation Facilities**: Foundation facilities are those which constitute the backbone of the research infrastructure and without which all or most of the other categories of research equipment can not function optimally e.g. the National Education and Research Network (NREN).

6. Funding considerations for a National Key Research and Technology Infrastructure (Chapter 7)

It is proposed that in the re-capitalization of the Key Research and Technology Infrastructure three different, yet coordinated approaches are adopted for the three broader categories of research equipment.

6.1 Well-found Laboratories

The strategy suggested for dealing with well-found laboratories is that institutions take full responsibility for the planning, capital investment, maintenance and upgrading, expansion and management for equipment for well-found laboratories. The decision on what should be placed in a well-found laboratory thus remains an institutional matter. By implication, funding for the well-found laboratory is largely derived from the parliamentary core grant to the two types of institutions under consideration in this strategy:

- **Science Councils and state owned science based enterprises**, including National Research Facilities, would normally sustain their fundamental infrastructure from their parliamentary grant, but subsidised by income derived from contract research.

- The same principle applies to **Higher Education institutions** which, ideally, should be able to maintain the fundamental research infrastructure of the well-found laboratory first and foremost from the recently introduced subsidy grants they earn on the basis of teaching inputs for masters and doctoral students, and the research outputs linked to research publications as well as graduated research masters and doctoral students. This can be supplemented from contract research and dedicated smaller equipment purchased from the research grants to researchers and their teams.

Interaction with the higher education sector in preparation of this strategy has shown that the infrastructure of the well-found laboratory is not up to standard and requires a once-off injection for refurbishment so that it can be maintained at the required levels under the new funding formula in future. Such a once-off capital injection to upgrade the well-found laboratory is primarily the responsibility of the Department of Education and should be motivated as such by this department to Treasury with the support of the DST. Allocations under such a scheme should be managed by the DoE. Submissions by higher education institutions to access these funds must be aligned to their research and research training strategies as outlined in their respective three year rolling plans, which in turn should be aligned to the National Research and Development Strategy.

The renewal fund for the well-found laboratory in higher education should consist of a once-off allocation to the Department of Education of R200 million per year for three years. After year three the well-found laboratory infrastructure should be maintained from the new research subsidy to higher education.

6.2 Big, expensive facilities (Foundation Facilities, International Facilities and National Facilities).

These categories of infrastructure normally require very high capital investments of a nature that often necessitates long term planning and implementation. Such mega-science (in South African context) initiatives require special motivation to Cabinet for support prior to implementation. Examples such as SALT, SKA and NREN are initiatives spearheaded by the DST as and when opportunities or needs arise. Long term, sustained funding of such facilities for management, maintenance, etc., is normally by way of special grants from the parliamentary science vote, whilst management responsibility is assigned to an agency. National research infrastructure such as research vessels and research bases in Antarctica would also fall under this category. In such instances the DST would need to liase very closely with the responsible line departments concerned.

6.3 World-class, multi-user equipment

Government contribution to the renewal and placement of world-class, multi-user equipment as defined above should primarily the responsibility of the Department of Science and Technology in support of the implementation of to the National Research and Development Strategy. Hence, consideration will be given to the following areas of research focus when making placement decisions:

- The national science missions based on the geographical advantages for South Africa
- The national science missions based on the knowledge advantage for South Africa
- The national technology missions
- The institutional and regional missions

The strategy for funding world-class equipment to support these missions would be to map the activities of major users of research equipment on the national and local science and technology mission spectrum according to long range research and equipment plans that will be supplied by research institutions. Longer term planning can then take place according to these declared interests.

Renewal and replacement of this type of equipment should, therefore, be in the form of a long-term programme that will make provision for the re-capitalisation of this type of equipment over a period of time. Funds will be used primarily for re-capitalisation, i.e.:

- replacements,
- new acquisitions and
- directed interventions to equip the science and technology missions

These funding categories can include support for associated infrastructure renewal that may be required for the placement and use of new equipment, such as e.g. ultra clean laboratories.

A certain portion of available funds will, however, have to be top-sliced annually to make provision for:

- maintenance and repair
- upgrades and refurbishment
- other recurring running expenses to maintain the equipment in serviceable condition, as well as
- ensuring access by researchers, viz. mobility grants

Several principles must guide the implementation of this funding strategy, viz.:

- Support is to be provided either in response to open calls based on the needs of the research community or calls aimed at directing the research agenda according to national needs and priorities
- Under both scenarios support is generally to be provided on a competitive nature to institutions of higher education and science councils
- Criteria for selection are to include
    - Appropriateness in terms of national/regional priorities and needs
    - Multi-users and accessibility
    - Potential for innovation and elevating quality and competitiveness of research
    - Technical support infrastructure

- Shared approach to funding
- Provision for support to ensure optimal and sustained serviceability
- Placement in most appropriate environment
- Contractual agreement with host institution for the duration of the life cycle of the equipment, that will make among others provision for governance structures which will include the user community.

7. Funding requirements for world-class, multi-user equipment

Based on the equipment survey of the National Research and Technology Audit, it is estimated that R230 million would be required annually for ten years to re-capitalise this category of research equipment over a ten year period (Chapter 8). There are, however, several considerations on the basis of which this amount can be reduced. These include:

- New funding strategies such as the Biotechnology Strategy, Innovation Fund, THRIP, Centres of Excellence etc. do make provision for the acquisition of some world-class equipment, albeit not of the more expensive type.
- Donors, such as the private sector, NGOs, trusts and such like, will continue to support the acquisition of expensive research equipment, particularly in the higher education sector.
- Technology advances not only make more and more equipment accessible electronically which obviates the necessity of the physical proximity of the equipment to the researcher, but also improve the capabilities of the equipment in terms of automation and throughput, so that fewer items of equipment can produce the same or even more volume of results.
- That institutions will be encouraged to co-invest in this type of equipment from own resources, as in the past.
- The rationalisation in higher education from 36 to 22 independent institutions and the focus on research intensive institutions will create economies of scale and also reduce the demand for duplicating certain types of equipment.
- An increased, dedicated mobility grant to facilitate access to research equipment will ensure that the equipment infrastructure is utilised optimally.

On the basis of these considerations the following amounts are considered the minimum required to re-capitalise the world-class, multi-user research equipment infrastructure:

- Capital expenditure for equipment, R100 million annually.
- Recurrent funds in support of sustainability of the equipment such as maintenance, upgrades and running expenses at 10 % of the capital investment for the duration of the life-cycle of the equipment.
- Mobility grants to enhance access to the equipment of R2 million initially and growing to R 5million in year ten

In order to achieve this, the MTEF amount needs to grow from R112 million in 2005/06 to R133 million in 2007/08 and ideally increase at this rate for the duration of ten years, the estimated time required to re-capitalise the world-class, multi-user equipment infrastructure. As these are non-inflation adjusted figures, some flexibility in the annual amounts is required to make provision for inflation and exchange rate fluctuations.

8. Key recommendations (Chapter 10)

8.1 Vision and Mission

The key recommendations of the strategy are that a ***National Research and Technology Infrastructure Programme*** be established.

The **vision** for such a programme should be:
Equipping South African science and technology for local relevance and global competitiveness

In support of this vision, the **Mission** is seen as providing an effective planning, funding and management system for a research infrastructure in South Africa to:

- Make the research base internationally competitive through a planned approach of supporting world-class research infrastructure that is responsive to new extensions in science and technology;
- Provide a top class equipment infrastructure for the training and development of the human capital essential for the generation of new knowledge and innovation;
- Involve research institutions in long range planning of their own research environments and how to equip these with appropriate research infrastructure;
- Support national science and technology missions as defined among others by the National Research and Development Strategy;
- Support institutional and regional missions as defined by provincial and institutional strategies; and

thereby to support economic growth and the provision of quality of life and well-being of all citizens in South Africa.

8.2 Summary of recommendations regarding the strategic objectives

The following are key recommendations on the identified strategic objectives.

Prioritising types of research equipment and the purpose of such equipment in terms of use and the focus of research requiring such equipment:

- Research equipment to be classified into two categories on the basis of where it is placed and how it is funded and managed, viz.: ***well-found laboratories*** and ***world-class infrastructure***.
- Research equipment to be placed and utilised for ***globally competitive research*** in addressing ***national*** and ***local priorities***, in accordance with the National R&D Strategy and emerging regional and local needs.

Differentiating Categories of Research Equipment for the purpose of ownership, management, funding and collaborative usage:

- Equipment of the **well-found laboratory**, generally used by one or several researchers and students within a department and funded by the institution from own funds or the researcher from his/her research grant.
- **World-class, multi-user equipment**, consisting of
    - Multi-user within institutional context (several users from different disciplines within one institution)
    - Multi-user in regional or national context (several institutions as users in a region or nationally)
- **Big, expensive facilities**
    - National Facilities, declared as such and managed by the NRF, as well as facilities such as the National Laser Center (NLC) and the Satellite Applications Centre (SAC) of the CSIR as well as the SAFARI nuclear reactor of NECSA.
    - International Facilities such as SALT, SKA
    - Foundation Facilities, e.g. the National Education and Research Network (NREN).

Creating a long range planning culture around research equipment in order to assess future equipment requirement scenarios for the country.

- Long range plans linked to world-class, multi-user equipment requests need to include:
    - a well-developed long-range (5 years minimum) research strategy,
    - a complete life cycle costing model for research equipment, including staffing, maintaining, repairing, upgrading and replacing the equipment, and
    - an exit strategy, i.e. the fate of the equipment at the end of its life cycle or, in case of the research cycle where the equipment will no longer be utilised.

Assigning responsibility for the funding and management of research equipment

- The funding of **well-found laboratories** will be the responsibility of the institution that requires a proper basic infrastructure to sustain research. It thus remains an internal institutional priority. It has to be recognised that an initial injection of funding over and above the current institutional budgets of higher education will be required from the Department of Education to strengthen the status of well-found laboratories in the country. Institutions will be fully responsible for the planning, funding and management of well-found laboratories from their respective primary income streams.
- The re-capitalisation of **world-class, multi-user equipment** needs to be funded by way of a Key National Research and Technology Infrastructure Programme over several years. Apart from the capital requirements, this programme must also make provision for the support of maintenance, upgrades and running expenses. Infrastructure of this nature is globally accepted as being for the public good and hence requires funding from the public purse. Government funding for this should be available to the DST, who in turn will appoint an agency to manage and disburse the funds on its behalf on the basis of predetermined principles and criteria identified in this strategy document.
- **Big, expensive facilities** require very high capital investments of a nature that often necessitates long term planning and implementation. Such big science initiatives are spearheaded by the DST as and when the needs arise, and require special motivation to Cabinet for support prior to implementation. Long term, sustained funding of such facilities for management, maintenance, etc., is normally by way of special grants from the parliamentary science vote, whilst management responsibility is assigned to an agency.

Establishing guidelines for economic models required to sustain the institutional research infrastructure in order to sustain the research equipment infrastructure base in the longer term.

- A policy be adopted by institutions on the depreciation of capital equipment in order to generate a replacement/maintenance/repair fund.
- A pricing policy be developed where service work for stakeholders and shareholders is conducted to recover some of the investment and running cost of research equipment.
- Costing and pricing policies for the full cost of conducting the work must be determined as accurately as possible, and include both direct and indirect costs.
- Proper planning in terms of supporting infrastructure, facilities and services needs to be in place. A clear plan for where research infrastructure will be housed and supported needs to be provided.

Introducing proper quality management of research equipment

- The development of a metric for return on investment for capital equipment based on recognised research outputs such as research publications, new technologies as reflected in patents, as well as numbers of masters' and doctoral students.
- A defined quality management process for funding as reflected in well-developed business plans to be submitted in the application process for research equipment.

- User committees need to be established as part of the governance of world-class, multi-user equipment

Identifying appropriate funding levels for re-capitalisation of equipment

- A renewal fund for the well-found laboratory in higher education. This, a once off allocation to the Department of Education of R200 million per year for three years, should be accessible to higher education institutions by way of a well motivated application aligned to the three-year rolling plans.
- Funding for the National Key Research and Technology Infrastructure Programme for the replacement and renewal of world-class, multi-user research equipment in higher education and science councils. This fund should make provision for
    - Capital expenditure for equipment of R100 million annually
    - Recurrent funds in support of sustainability (maintenance, upgrades, running) of the equipment, equivalent to 10 % of the capital investment
    - Mobility grants to enhance access to the equipment of R2 million and growing to R5 million.

The National Key Research and Technology Infrastructure Grant Fund should therefore grow from R112 million in year one to R133 million in year three, and ideally grow at this rate over ten years, i.e. the time required to re-capitalise the infrastructure. Provision needs to be made to adjust these figures for inflation and exchange rate fluctuations from time to time.

Ensuring optimal use of world-class research equipment in a sustained manner

- Research equipment should be placed where demonstrated capacity exists in the human resource and skills base.
- The record of accomplishment of the applicants for the equipment with specific reference to productivity must be taken into consideration
- That host institutions take up the responsibility for the training of researchers to use the equipment
- That training of operators, maintenance technicians and researchers by manufacturers and suppliers is negotiated as part of the purchase of the equipment.
- That the respective responsibilities of the host institution and the Programme management regarding the sustained use for the duration of the life cycle of the equipment be agreed upon by way of a Memorandum of Understanding

Assuring access to research equipment by providing grant funding for mobility of researchers

- That a mobility grant is added to the funding environment of the National Key Research and Technology Infrastructure Programme to cover the costs of South African researchers travelling and staying over to use research equipment.
- The mobility grant will be primarily for the costs of travel and accommodation. Costs for using the equipment and to cover any direct running expenses (e.g. consumables) should where possible be recovered from the research grant available to the applicant.