Australian Government

Department of Innovation
Industry, Science and Research

Strategic Framework for Research Infrastructure Investment

Discussion Paper

December 2010

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Foreword

> "It is widely accepted that investment in innovation, including research, drives productivity, and that excellent research infrastructure is necessary to facilitate the delivery of high quality scientific research. It is important to ensure that the approach used to plan, fund and develop research infrastructure delivers the maximum scientific outcome for the nation, for the money invested."
>
> NCRIS Evaluation Report 2010

Access to world class research infrastructure, either in Australia or overseas, is vital if Australia is to remain a leading research and innovation nation so that we prosper sustainably and improve our quality of life. The Australian Government recognises that resources to invest in research infrastructure are finite and, hence, sensible choices need to be made.

The National Research Infrastructure Council (NRIC) was established by the Government to provide strategic advice on research infrastructure investment. Its terms of reference specifically asked the Council to provide advice to the Government in the form of a Strategic Framework for Research Infrastructure Investment. The Framework will help guide future policy with respect to research infrastructure and the design of future funding programs.

The Council has considered a broad range of issues which cover the whole Australian research sector. In many cases the principles that should apply seem clear. In some cases it is less clear and judgments need to be made. The issues were canvassed at the recent Research Infrastructure Forum which provided valuable feedback. The Council is seeking comment on this discussion paper to help refine the Framework before submitting its advice to the Minister and the Government.

The Council appreciates the assistance it has received from the Department of Innovation, Industry, Science and Research in the preparation of this document and looks forward to receiving your comments.

On behalf of the Council

John Ryan
Chair
National Research Infrastructure Council

Introduction

Powering Ideas, the Australian Government's blueprint for the future development of the national innovation system, announced the creation of the National Research Infrastructure Council (NRIC) to provide strategic advice on future research infrastructure investments.

NRIC has been established to:

- Develop a strategic framework for investment in research infrastructure in Australia;
- Provide advice to the Minister on research infrastructure investment issues including national and landmark priorities, funding needs, improved program linkages and delivery methods; and
- Assess funding proposals for specific research infrastructure investments and monitor Australian Government investments in research infrastructure.

The Council is chaired by Mr John Ryan, Executive Director, Cloon Economics and former Deputy Secretary of the Department of Resources, Energy and Tourism. The members of NRIC include a number of ex-officio members such as the CEOs of the Australian Research Council, the National Health and Medical Research Council and the CSIRO, as well as research leaders from across a wide range of research disciplines. Two members of NRIC are also on the Education Investment Fund Advisory (EIF) Board.

The NRIC terms of reference and membership can be found at:
http://www.innovation.gov.au/Section/science/Pages/nric.aspx

The development of a strategic framework to guide future research investment is a key task for NRIC to meet the expectations of the Government and the sector.

The Strategic Framework is intended to encompass the current research infrastructure system, and provide a high-level framework to guide the development of policy advice and the design of programs related to the funding of research infrastructure by the Australian Government.

It is intended that the Strategic Framework will be sufficiently broad and flexible that it will also be able to be used by other agencies involved in research infrastructure funding, and provide the basis for a more coordinated and integrated approach to investment across the sector. It is hoped that the Strategic Framework will provide the basis for new policy approaches to the funding of research infrastructure across the system.

This discussion paper is the result of research and discussion undertaken by NRIC and the Department of Innovation, Industry, Science and Research. It draws heavily on the work and consultation undertaken in the development of a number of earlier policy and review documents, which are described briefly in the background section.

It also draws on the recent consultation conducted by NRIC with key stakeholders on a proposed process for identifying and prioritising landmark infrastructure, and on discussions at the Research Infrastructure Forum held with a number of key stakeholders in early October 2010.

NRIC is seeking stakeholders' input into the development of the strategic framework through this discussion paper. The paper outlines the possible key components of a proposed strategic framework with questions and options for consideration. It also

briefly describes aspects of the current research infrastructure landscape in Australia, and notes some of the key issues to be addressed.

Stakeholders wishing to raise issues not covered in this paper are encouraged to put them forward for consideration.

Responses to the Discussion Paper should be sent to the NRIC Secretariat by COB Friday, 11 February 2011.

Contact details

NRIC Secretariat
Research Infrastructure and Science Policy Branch

Department of Innovation, Industry, Science and Research
GPO Box 9839
CANBERRA ACT 2600

Email: nric@innovation.gov.au
Phone: 02 6213 7253

Background

The need for a more strategic approach to providing the high-quality infrastructure necessary for world-class research was identified in 2000 in the Chief Scientist of Australia's discussion paper *The Chance to Change*[1] and in the final report of the Innovation Summit Implementation Group, *Innovation: Unlocking the Future*[2].

In August 2003, the Australian Government established the National Research Infrastructure Taskforce (NRIT) to develop a nationally integrated research infrastructure strategy to apply to all publicly funded higher education institutions and research agencies. It was also charged with examining existing programs and making recommendations on the best approach to providing funds for major research infrastructure.

In its final report[3], released in March 2004, NRIT recommended a set of principles and a national process to identify, prioritise and fund research infrastructure needs. One of the key findings of the NRIT report was that Australia needed to strengthen, plan and prioritise research infrastructure. It also highlighted concerns with the ad hoc nature of the Major National Research Facilities Program (MNRF) and the Systemic Infrastructure Initiative (SII), such as:

- the competitive process not encouraging submissions that reflected overall infrastructure priorities and provided the best potential collaboration and co-investment; and
- the limited ability to keep skilled staff to operate research infrastructure, leading to issues with maximising use.

In response to the NRIT report, the Australian Government announced the National Collaborative Research Infrastructure Strategy (NCRIS) in the 2004-05 Budget. This program was allocated $542 million from 2004-05 through to 2010-11 to provide researchers with access to major research facilities and the supporting infrastructure and networks necessary to undertake world-class research.

NCRIS introduced significant changes in the approach to prioritising, planning and investing in research infrastructure compared with previous research infrastructure funding programs, in particular strengthening the focus on collaboration. Some of the key characteristics of the NCRIS program are the consultative roadmapping of strategic priorities, a strategic process as opposed to a simple competition to determine funding allocation, a fundamental focus on collaboration and the ability to fund operating costs.

The recently released NCRIS Evaluation Report[4], (June 2010) stated that incorporation of the key features of NCRIS should be considered in the development of policy for future research infrastructure programs.

The 2008 Review of the National Innovation System *(Venturous Australia – building strength through innovation*[5]) also highlighted the need for a coordinated, collaborative and strategic approach to research infrastructure investment. While the review recognised such an approach is emerging, for example through NCRIS, it articulated a requirement for national coordination across different levels of investments, and the

[1] *The Chance to Change* Discussion Paper by the Chief Scientist, 2000.
[2] *Innovation: Unlocking the Future*, 2000, www.the-funneled-web.com.
[3] *Final Report of the National Research Infrastructure Taskforce*, 2004, http://ncris.innovation.gov.au/Documents/NRIT_Report.pdf.
[4] *National Collaborative Research Infrastructure Strategy Evaluation Report*, 2010, pg 1.
[5] *Venturous Australia – building strength in innovation*, 2008, http://www.innovation.gov.au/innovationreview/Pages/home.aspx.

institutions managing those investments. The review recommended funding for a successor program to NCRIS for 10 years including capital and operational support of $150 million to $200 million per annum. It also recommended the creation of a National Research Infrastructure Committee to advise the Government on strategic directions in funding of national research infrastructure, including landmark infrastructure.

In May 2009, the Australian Government released *Powering Ideas*[6], its innovation policy agenda to 2020. The Government committed to continuing investment in research infrastructure to support collaboration and give Australian researchers access to the latest technology. As part of the policy agenda, the Government announced the creation of the National Research Infrastructure Council (NRIC) to provide strategic advice on future research infrastructure investments.

The Australian Government is not alone in committing to a more strategic approach to research infrastructure investment. A strategic approach recognises the need to consider investment in an international context, taking account of the reality of the international nature of research.

Many countries are actively engaged in strategic research and science priority setting across the globe and are also undertaking strategic, long-range planning exercises. In countries where a top-down approach dominates, the central government adopts explicit strategies, policies or plans that specify priority areas of research (e.g. Austria, China, Japan and Norway). Most of these countries, as well as some others (e.g. Netherlands, Denmark, Germany and Korea) have some kind of central advisory body that makes recommendations about priorities[7]. A summary of the current revised or new national plans for science, technology and innovation policy in Australia and similarly sized GDP investment economies, as well as the United States, is provided in Table 1.

The European Strategy Forum on Research Infrastructures (ESFRI) 2008 Roadmap[8] is an example of the kinds of strategic planning activities being undertaken directly related to research infrastructure. The 2008 Roadmap aims to integrate national resources into a common, pan-European effort.

The mission of ESFRI is to support a coherent and strategy-led approach to policy-making on new and existing pan-European and global research infrastructures. The activities of ESFRI have led to a number of benefits, including the emergence of national roadmaps to guide investment and the mobilisation of scientific communities to create their own thematic roadmaps where the needs of their disciplines in the short, medium and long term are clearly identified.

Consistent with international practice, NRIC considers that the development of a strategic framework is a key step in fostering a strategic, coordinated approach and should provide the guiding principles for research infrastructure investment for Australia through to 2020.

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[6] *Powering Ideas: an innovation agenda for the 21st century*, 2009, http://www.innovation.gov.au/innovationreview/Pages/home.aspx.

[7] OECD – *Policy Setting for Public Research: Challenges and Opportunities 2010.* Directorate for Science, Technology and Industry: Committee for Scientific and Technological Policy.

[8] *European Roadmap for Research Infrastructures* – Roadmap 2008, http://ec.europa.eu/research/infrastructures/index_en.cfm?pg=esfri-roadmap&section=update-2008.

Table 1: Current revised or new national plans for science, technology and innovation policy in Australia and similarly sized GDP investment economies and the United States[9].

Country	National Plan	Period	Main objectives
Australia	Powering Ideas: An Innovation Agenda for the 21st Century	2009-20	Integration of innovation across the economy, supported by a substantial boost in funding to: improve high-quality research; reinforce the base of skilled researchers; foster industries of the future and secure value from R&D commercialisation; improve dissemination of new technologies, processes and ideas; encourage a culture of research; increase sectoral and international collaborations on R&D; and improve policy development and service delivery.
Canada	Mobilizing Science and Technology to Canada's Advantage	2007 Onwards	The strategy is based on four guiding principles: promoting world-class excellence; focussing on priorities; fostering partnerships; and enhancing accountability. In June 2009, the government released a progress report on the implementation of the strategy, and expressed its commitment to bring forward investments to make Canada a world leader in science and technology.
China	Medium- and Long-term Programme for Science and Technology Development	2006-20	Enhance China's S&T and innovation capabilities; use innovation as a tool for restructuring Chinese industry; shift growth modes from investment-driven to innovation-driven; build a conservation-minded and environmentally friendly society; and enhance independent innovation capabilities as a national priority. Raise R&D investment to 2.5% of GDP by 2020; rank in the world top five in patenting and international citations.
Sweden	Sweden Research and Innovation Bill	2009-12	Successive increased in central government support during 2009-12, to reach a permanent increase of SEK 5 billion to 2012 (Euro 500 million) – total addition of SEK 15 billion. The bill implements the largest reform of funding system for basic research in over 60 years (introduction of appropriations by strategic areas). Strengthening quality relevance and competitiveness with a view to maintaining Sweden's place in the international research arena.
Switzerland	Education, Research and Innovation (ERI) Dispatch	2008-11	The goal of all planned measures is to enable the players and institutions of the ERI sector to extend Switzerland's capacities as a location for thought and work. Education is guided by the principle of securing and improving quality, and the goal in research and innovation is increased competitiveness and growth.
United States	A Strategy for American Innovation: Driving Towards Sustainable Growth and Quality American Recovery and Reinvestment Act (ARR)	From 2009 2009-13	The US Innovation Strategy is organised around three pillars: invest in the building blocks of American Innovation, including R&D and human, physical and technological capital; promote competitive markets that spur productive entrepreneurship; and catalyse breakthroughs for national priorities such as developing alternative energy sources and improving health outcomes. Out of the USD 787 billion allocated under the ARR, USD 100 billion will be used to support investment in innovative and transformative programmes. In this context, four areas are targeted: modernisation of transport, including advanced vehicle technology and high-speed rail; renewable energies (wind and solar); broadband, Smart Grid, and health IT; and ground breaking medical research.

[9] OECD – *Priority Setting for Public Research: Challenges and Opportunities 2010*. Directorate for Science, Technology and Industry: Committee for Scientific and Technological Policy.

Current arrangements

Funding sources for research infrastructure in Australia are diverse and include not only the Australian Government, State and Territory Governments and research institutions, but also the philanthropic sector. Each of these providers has its own criteria and priorities for investing in research infrastructure. The key characteristics of current funding programs in Australia and the different approaches taken in each are important to consider in developing the strategic framework.

Australian Government Programs

The Australian Government is the dominant provider of funds for public research infrastructure and facilities, particularly in the national and landmark categories. Funding is provided through a range of programs administered by departments, the Australian Research Council (ARC) and the National Health and Medical Research Council (NHMRC) and through direct budget allocations. Each of the programs has different characteristics depending on the scale, intended impact and allocation mechanism.

A brief description of the existing programs and their key characteristics is provided below.

National Collaborative Research Infrastructure Strategy (NCRIS)

Announced in the 2004-05 Budget, NCRIS[10] is providing $542 million from 2004-05 to 2010-11 to develop and fund national research infrastructure projects.

The key characteristics of NCRIS that differed from previous programs such as MNRF and SII are:

- an emphasis on collaboration from the outset;
- the strategic identification of capabilities through a consultative roadmapping process;
- the strategic rather than competitive process for funding allocation;
- use of a facilitation process to develop capability plans; and
- the provision of funding for skilled staff and operating costs.

Funding being provided to individual projects under this program ranges from $20 million to $75 million over five years.

The 2006 Strategic Roadmap[11] developed as part of NCRIS was subsequently reviewed and updated. In the context of the Review of the National Innovation System in 2007-08, there was a need to reconsider future priorities for research infrastructure investment and therefore another roadmapping process was initiated. The 2008 Strategic Roadmap[12] built on the 2006 Roadmap and presented a renewed view of where strategic infrastructure investments should be made over the following five to 10 years.

[10] http://ncris.innovation.gov.au/
[11] http://ncris.innovation.gov.au/Pages/SRARI.aspx
[12] http://ncris.innovation.gov.au/Pages/SRARI.aspx

Education Investment Fund (EIF)

The Education Investment Fund (EIF)[13] was announced in the 2008-09 Budget. The role of the EIF is to build a modern, productive, internationally competitive Australian economy by supporting world-leading, strategically-focused infrastructure investments that will transform Australian tertiary education and research.

The EIF is one of three Nation-building funds established by the Government to provide investment in infrastructure, along with the Building Australia Fund and the Health and Hospitals Fund. All three funds are governed by the *Nation-building Funds Act 2008*.

The key characteristics of the EIF are:

- Funding is only available for the creation and development of infrastructure and is therefore not available for operational costs or the facilitation of collaborative projects;
- Projects must meet a set of evaluation criteria, including the extent to which the project will address national priorities (such as the National Research Priorities and those outlined in the Strategic Roadmap for Australian Research Infrastructure); and
- Collaborative, multi-disciplinary and/or cross sectoral projects are encouraged.

Processes for the each of the three funding rounds conducted under the EIF to date – and the fund it superseded (the Higher Education Endowment Fund) – have varied between rounds, particularly in terms of the timeframes available to submit applications. The total funding committed under the three rounds to date is over $2 billion, of which $746 million has been provided for research infrastructure.

The amount of funding provided for research infrastructure projects across the EIF rounds has ranged from $18 million to $90 million.

Health and Hospitals Fund (HHF)

The Health and Hospitals Fund (HHF)[14] is another of the three Nation-building funds established by the Government and governed by the *Nation-building Funds Act 2008*.

The objectives of the HHF are to:

- Invest in major health infrastructure programs that will make significant progress towards achieving the Commonwealth's health reform targets; and
- Make strategic investments in the health system that will underpin major improvements in efficiency, access or outcomes of health care.

The HHF has invested in significant medical research infrastructure, including projects such as the Hunter Medical Research Institute (NSW), the Translational Research Institute (Qld) and the Health and Medical Research Institute (SA).

Two rounds of the HHF have been undertaken and a third round, with a focus on regional health infrastructure, closed in early December 2010. The first two rounds have allocated funding of $3.2 billion, of which over $430 million has been directed towards medical research and workforce infrastructure to improve the transfer of research outcomes into patient care.

[13] http://www.deewr.gov.au/HigherEducation/Programs/EIF/Pages/default.aspx
[14] http://www.health.gov.au/hhf

Super Science

The Super Science Initiative[15] was announced in the 2009-10 Budget as part of the Government's *Powering Ideas* policy agenda and is providing $901 million from 2009-10 to 2012-13 for cutting edge research infrastructure. The funding for the Super Science Initiative is provided from the EIF. The Super Science Initiative itself is not an ongoing program.

Funding being provided to individual projects under this initiative ranges from $10 million to $120 million over five years.

The *Strategic Roadmap for Australian Research Infrastructure*[16] released in 2008 formed the evidence base for the funding of the Super Science Initiative.

While Super Science shared some characteristics with NCRIS, such as the use of the consultative roadmapping and a focus on implementing national, collaborative infrastructure with supporting access and pricing regimes, other important features were not able to be included because of the constraints on the use of EIF funding, particularly the inability to fund operating costs.

Linkage Infrastructure, Equipment and Facilities (LIEF)

The Australian Research Council (ARC) provides funding for LIEF[17] through the National Competitive Grants Program (NCGP). The LIEF scheme fosters collaboration through its support of the cooperative use of national and international research facilities. It provides funding for cooperative initiatives so that expensive infrastructure, equipment and facilities can be shared by researchers in partnered organisations. However, the ARC funds single-eligible organisation proposals where the case is well justified.

LIEF is targeted at infrastructure to support ARC funded research, which is typically of a smaller scale relative to NCRIS, EIF and Super Science. LIEF funding is awarded through a rigorous competitive process with a high level of consistency between the process and timeframes for each round. The competitiveness of LIEF proposals is enhanced where there is a strong "need for excellent Australian researchers to access the proposed infrastructure, equipment and facilities". LIEF has provided funds for access to a limited number of national and international facilities, where the annual investment is small (< $1 M pa) and there has generally been a historical element to the funding.

For LIEF projects commencing in 2011, an ARC investment of $30.9 million will fund 78 projects, of which 7 are single-eligible organisation projects[18]. The amount of funding granted for LIEF projects commencing in 2011 ranged from $140,000 to $1.3 million.

National Health Research Enabling Capabilities (NHREC)

The National Health and Medical Research Council (NHMRC) has developed the National Health Research Enabling Capabilities (NHREC) scheme[19] to replace its Enabling Grants scheme. The aim of the NHREC scheme is to support high quality,

[15] http://www.innovation.gov.au/Section/science/Pages/superscienceinitiative.aspx
[16] http://ncris.innovation.gov.au/Pages/SRARI.aspx
[17] http://www.arc.gov.au/ncgp/lief/lief_default.htm
[18] http://www.arc.gov.au/ncgp/lief/LIEF11_selrpt.htm
[19] http://www.nhmrc.gov.au/grants/apply/infrastructure.htm

world-class research capabilities and facilities that will enhance the national health and medical research effort in Australia, be accessible to researchers nationwide and which are essential for NHMRC-funded research. It seeks to add value to current NHMRC research funding by creating a more strategic approach to the identification of national health research needs. The scheme is designed to fund smaller scale facilities (currently up to $1-2 million per year) and support is available for a maximum period of five years.

Block Grants

A variety of Australian Government programs provide funding to organisations to support the indirect costs of research – such as infrastructure – not covered by the competitive grants schemes. These grants are allocated using performance based formula. Block Grants do not require the organisation to use the funds on specific projects or areas of intent. Such grants provide the flexibility for organisations to make investments based on their own priorities, which might include developing capacity to undertake research in emerging research areas.

The formula for grants such as the Research Infrastructure Block Grant Scheme (RIBG)[20], and the NHMRC's Equipment Grants[21] and the Independent Research Institute Infrastructure Support Scheme (IRIISS)[22] is based on a calculation of the relative success of an organisation in attracting research income from competitive funding schemes.

The Sustainable Research Excellence (SRE)[23] program announced in *Powering Ideas* will augment RIBG and provide additional support to universities in meeting the indirect costs of their research activities. Its other objective is to support universities to build and maintain research excellence through the implementation of best practice financial management, performance and reporting frameworks.

The future funding formula is still being considered, but the most recent consultation document outlined options using a combination of:

- the level of Australian Competitive Grant Income;
- the results of the Transparent Costing exercise; and
- the results of the Excellence in Research for Australia (ERA) process.

Direct budget allocations

Some support for research infrastructure is provided through budget allocations of funding for publicly funded research agencies and other research organisations.

Direct budget allocations are also the primary source of funding for landmark research infrastructure, such as the Australian Nuclear Science and Technology Organisation research reactor. There has not been an agreed process to identify and prioritise landmark research infrastructure investment to date; however NRIC has developed a proposed process in consultation with key stakeholders for the Minister's consideration.

[20] http://www.innovation.gov.au/Section/Research/Pages/ResearchInfrastructureBlockGrantsScheme.aspx
[21] http://www.nhmrc.gov.au/grants/types/granttype/infrastructure.htm
[22] http://www.nhmrc.gov.au/grants/types/granttype/infrastructure.htm
[23] http://www.innovation.gov.au/Section/Research/Pages/SustainableResearchExcellence(SRE).aspx

State and Territory Government Programs

The Australian Government is not the only Government in Australia investing in research infrastructure. State and Territory Governments also provide significant funds for research infrastructure and are likely to invest with a view to the interests of their jurisdictions. They may also make investment decisions to leverage the advantages of funding from the Australian Government and other sources.

State Government programs in this area include the Science Leveraging Fund and TechVouchers programs in New South Wales. The Victorian and Queensland Governments have previously funded programs in this area: the Science Technology and Innovation Initiative and the Smart State Strategy respectively. The South Australian Government, through its Science and Information Economy Directorate, facilitates the identification and coordination of relevant local research communities to engage and contribute to national research infrastructure of relevance to South Australia. Whilst NSW is the only State with a current program specifically targeted to research infrastructure investment, other States and Territories have indicated interest in new programs being implemented in the future.

Other sources of funding

Philanthropic organisations are increasingly important in providing funding for research infrastructure. This is particularly true in the medical research sector where philanthropic organisations have supported such facilities as the Clive Berghoffer Cancer Research Facility and the Walter and Eliza Hall Institute. Such organisations are usually guided by their own missions and goals rather than priorities identified by governments.

The private sector is a large source of funding for research and development in Australia. Although private firms invest in their own research infrastructure, this investment is to meet their specific needs and is not usually accessible by public researchers.

International dimension

Australian investment in research infrastructure is not limited to Australian based facilities. In some instances, it is more appropriate for Australia to contribute to multinational facilities to gain the best benefit for Australian science.

Australia is a direct investor in some international research infrastructure, such as the Giant Magellan Telescope (GMT) and CERN. There are clear benefits in contributing to an international collaboration to create global infrastructure. Such infrastructure is unlikely to be able to be built by Australia alone and, by being part of a global collaboration, we ensure Australian researchers are able to access the best kit in the world.

Australia also subscribes to international facilities, such as the Gemini Observatory and the Global Biodiversity Information Facility. By becoming a subscriber or member, Australia purchases a ‘seat at the table’ in an international field or forum, which in turn facilitates access to international facilities, data and learned institutes.

Investment in international infrastructure ensures that Australia has a high level of engagement with global science community.

Proposed components of a strategic framework

As described in the previous section, there are currently several programs to support different aspects of research infrastructure. The Government is seeking advice from NRIC on how to create a more cohesive and coordinated landscape, particularly in terms of the development of future research infrastructure funding programs.

The recent NCRIS Evaluation and the experience gained through implementing the Super Science Initiative and the Education Investment Fund projects have provided valuable insight into the strengths and weaknesses of different approaches to research infrastructure funding.

The issues that have arisen from these experiences, and from discussions at NRIC and consultation with stakeholders, can be grouped under a number of broad headings.

This section seeks to articulate the questions and importance of each of these issues, leading to further discussion and possible responses to each.

The objective of the framework is to identify principles which will guide the development of policy advice and design of future programs related to the funding of research infrastructure.

The paper also seeks to highlight that each of the principles can apply to a relative extent, depending on the scale of the research infrastructure investment. For the purpose of this paper, investment in research infrastructure has been divided into three groups:

- **Local** – research infrastructure which could be expected to be owned and operated within a single institution.
- **National** – research infrastructure on a scale not appropriate to be owned or operated by a single institution and which often supports collaborative research and is generally regarded as part of the national research capability.
- **Landmark** – large-scale facilities (which may be single-site or distributed) that serve large and diverse user communities, are generally regarded as part of the global research capability, and engage national and international collaborators in investment and access protocols.

It is also a basic assumption of this discussion paper that ICT infrastructure is a pervasive and underpinning requirement needed to support all research and research collaboration. The evolution in the recognition of the role of eResearch infrastructure has been marked over recent years, particularly in light of the fact that almost a third of funding under the Super Science initiative was allocated to eResearch infrastructure. Access to data, advanced networks, high performance computing facilities and collaboration tools are now fundamental underpinning research infrastructures across a wide range of disciplines and research activities.

Definition of infrastructure

A clear definition of research infrastructure is required in order to have a shared understanding of the scope of considerations in the Strategic Framework, and in any future funding programs.

Different countries and organisations define research infrastructure in different ways. This arises from the various contexts in which the term is used and the need to encompass support for the full range of research endeavours including science and the humanities, and the broad range of infrastructure required including major facilities, equipment and distributed infrastructure.

Definitions differ slightly depending on the goals and outcomes of each particular investment program. While this provides flexibility, this has resulted in some key elements of research infrastructure not being picked up in the system, namely the provision of operating and maintenance costs.

NRIT proposed the following definition of research infrastructure:

> Research infrastructure comprises the assets, facilities and services, which support organised research across the innovation cycle and which maintain capacity of researchers to undertake organised research.
>
> The Taskforce excludes academic personnel directly responsible for research and the direct cost of their research (such as, travel and consumables)[24].

In addition to adopting the NRIT definition, the NCRIS Investment Framework included the following advice for facilitators in developing their investment plans:

> NCRIS funding may be applied to the establishment, operation and development of research infrastructure facilities, including associated staffing costs. This may include a mix of expenditure on:
>
> - Operation of existing facilities;
> - Enhancement of existing facilities;
> - Establishment and operation of new facilities; and
> - Gaining access to offshore facilities.
>
> As the NCRIS programme is aimed at the implementation and development of research infrastructure, NCRIS funds must not be applied to research activities themselves[25].

The NCRIS distinction between research infrastructure and research activities was provided in part to differentiate NCRIS from some earlier programs which had included some elements of research, such as the Systemic Infrastructure Initiative, and to place research-related costs clearly in the research funding sphere.

There are advantages to having an agreed definition including supporting a broader understanding with respect to the role of funding programs.

Definitions used in other jurisdictions have sought to clarify slightly different issues, particularly in terms of the place of collections and ICT infrastructures in the broader research infrastructure context.

[24] http://ncris.innovation.gov.au/Documents/NRIT_Report.pdf (2004), p.5.
[25] http://ncris.innovation.gov.au/Documents/Invest_Framewk.pdf, (2006), p.13

The European Strategy Forum on Research Infrastructure and the European Commission both define research infrastructure by providing a list of examples that are explicitly included:

> …facilities, resources and related services that are used by the scientific community to conduct top-level research in their respective fields. This definition covers: major scientific equipment or set of instruments; knowledge-based resources such as collections, archives or structured scientific information; enabling ICT-based e-Infrastructures such as Grid, computing, software and communication networks; any other entity of a unique nature essential to achieve excellence in research[26].

However research infrastructure is defined, inclusion explicitly or implicitly in a definition will not necessarily result in particular types of infrastructure being funded.

A key issue that has arisen in this respect, which was particularly pertinent in NCRIS considerations, was that of the digitisation of research collections and whether that could be considered as an infrastructure investment. It was the view of the NCRIS committee that digitised collections are in fact research infrastructure.

It is therefore considered valuable to establish a definition of research infrastructure within the Strategic Framework to ensure that it captures an appropriately broad range of elements while avoiding the consideration of that which is properly identified as research.

It is also important to recognise at a fundamental level that research infrastructure located in Australia forms part of an international research community and that key research infrastructure required and used by Australian researchers can include facilities and instruments located in other parts of the world.

NRIC also considers that the definition should explicitly reference the excellent research and innovation outcomes expected from research infrastructure investment – to deliver the maximum outcome for the nation for the money invested.

The following is NRIC's proposed definition:

Definition of Research Infrastructure

Research infrastructure comprises the assets, facilities and services which support research across the innovation system and which maintain the capacity of researchers to undertake excellent research and deliver innovation outcomes.

Continuity of funding

There are two broad sets of concerns within the issue of continuity of funding:

1. ongoing, predictable funding for research infrastructure programs; and
2. continuity of funding for individual projects where they continue to be a priority.

The first issue was highlighted in the NRIT report[27]. During the consultations undertaken by NRIT, concerns were expressed at the ad hoc nature of the Systemic

[26] European Commission, *Framework Program 7 Capacities Work Programme: Infrastructures* http://ec.europa.eu/research/infrastructures/pdf/n_wp_201001_en.pdf#view=fit&pagemode=none, July 2009, pp 3 - 4.
[27] http://ncris.innovation.gov.au/Documents/NRIT_Report.pdf (2004), p 7.

Infrastructure Initiative (SII) and the Major National Research Facilities Program (MNRF), which was said to:

- undermine research institutions' capacity to plan and prioritise research infrastructure needs; and
- encourage submissions that do not necessarily reflect overall infrastructure priorities, do not provide the best potential collaborations and co-investment and are not carefully costed.

The 2008 Review of the National Innovation System *(Venturous Australia – building strength through innovation*[28]) also highlighted the episodic and ad hoc approach to funding infrastructure for research in Australia and recommended ongoing funding for a successor program to NCRIS for 10 years, including capital and operational support, of $150 to $200 million per annum.

The ad hoc nature and variable lead times of the EIF funding rounds has affected the quality of submissions. In the second round of EIF, for example, institutions had two weeks' notice to submit funding applications in what was an accelerated round to feed into the Government's fiscal stimulus program. While the funding available in that round was widely welcomed, the lack of notice meant that some project applications were clearly put together very quickly and not of a sufficient quality. Successful projects in that round were likely to have been in development within the institutions for some time, in case an opportunity arose to seek funding.

In more normal circumstances, greater notice of the opening of rounds should result in higher quality applications and level the playing field somewhat, so that the best ideas have a better chance of success, rather than those that happen to be ready at the time. It will also encourage reasonable behaviour by those seeking funding in that proposals for investment would be more likely to come forward when needed and mature rather than be rushed in response to periodic and unpredictable funding rounds.

The regular nature of funding opportunities and the ability to undertake long term planning to best take advantage of these opportunities is one of the highly valued features of the ARC's LIEF program.

The second issue is particularly relevant to national or landmark scale research infrastructure. These projects require long term investment, often with considerable planning and construction times, and lifetimes that can be measured in decades. Commitment to funding such infrastructure facilities in the medium to long term is an element that has often been missing from funding programs. *Powering Ideas* recognised the importance of a commitment to long-term support for innovation in general. It noted that groundbreaking innovation requires sustained commitment, sometimes for decades. Translating new ideas requires an innovation system that offers an unbroken path from vision to realisation.

Beyond running costs, expenses such as upgrades, routine maintenance, replacement of components and natural growth are not currently provided for, which may result in shorter than optimal viability for some infrastructure assets, with resultant impacts on research capacity. As noted in *Powering Ideas*[29], when making investments in research and innovation infrastructure, it is essential that we keep thinking beyond the needs of today.

[28] *Venturous Australia – building strength in innovation*, 2008, http://www.innovation.gov.au/innovationreview/Pages/home.aspx.
[29] *Powering Ideas: An Innovation Agenda for the 21st Century* 2009, p 53.

The absence of an identified successor program for NCRIS, for example, has raised concerns within the sector that some research infrastructure that has been developed through NCRIS will cease to be supported or available at the end of that program's funding.

This raises serious issues for host institutions, where expectations of ongoing operation and access exist beyond the life of a funding program but the external funds to support access have ceased. There are also flow-on effects for researchers who rely upon the infrastructure as part of the basis for their research.

Similarly, the time and cost expended in establishing effective sector-based governance structures, such as the company that implements AuScope or the less formal collaborative arrangements underpinning the Integrated Marine Observing System, are such that a short or undefined period of operation acts as a disincentive to establishing effective collaborative structures such as these.

Thus, commitment to continuity of funding should be a central consideration for the provider of the funding. Continuity of funding for infrastructure will facilitate effective strategic planning by institutions and the research community. In addition, there are examples where the infrastructure requires ongoing custodianship (such as collections and databases), or data streams that are of value only when they are continuous. For landmark infrastructure, funding certainty for the useful life of the project is likely to be desirable.

This commitment to providing some measure of certainty around funding for ongoing operations of research infrastructure must also include a mechanism for terminating investments and concluding projects. Therefore ongoing funding should only be available for infrastructure that continues to be a national priority.

Principles – Continuity of funding

- **Research infrastructure funding programs should be ongoing and predictable.**
- **Infrastructure that continues to be a priority should be able to access funding for ongoing operations.**

Holistic funding

In 2004, NRIT noted that the funding of "whole-of-life" costs was vital for the sustainability of research infrastructure[30]. This led to the decision to incorporate support for governance, operating costs, maintenance and skilled technical support into the NCRIS program. As noted in the *NCRIS Evaluation Report*, this was one of the most successful aspects of the program, and was overwhelmingly supported by stakeholders.

Amongst other key findings, the evaluation found that the NCRIS program is cost-effective; one of the particular outcomes that contributes to its cost-effectiveness is its

[30] Recommendation 7 – *Final Report of the National Research Infrastructure Taskforce*, 2004.

willingness to invest in human capital and operating costs, resulting in superior service delivery and viability of facilities[31].

The NCRIS evaluation also found that:

> Current uncertainty about future funding for research infrastructure, particularly the provision of funding for operating costs and specialist staff, creates management difficulties for current capabilities and places Australia at risk of losing the highly-skilled work-force required for the efficient operation of sophisticated facilities[32].

As the EIF can only fund the creation and development of research infrastructure, key aspects supported by NCRIS are not able to be funded from EIF, through Super Science or competitive rounds.

These include:

- Governance structures, payments to Boards, costs of maintaining company or other corporate structures;
- Outreach activities, which have been used in NCRIS to ensure broad awareness of research infrastructure and to maximise the effective uptake and use of that infrastructure;
- Operating costs, such as the significant power bills for high performance computing facilities, essential to their operations; and
- Skilled technical staff to support researchers' use of facilities.

In particular, the inability to fund operational costs and skilled technical and specialist staff have been seen by many sector participants as a step backwards from the progress made in the design of NCRIS. Indeed, the NCRIS evaluation found that funding operational costs produced a more efficient and productive use of facilities[33].

While other participants would be able to fund these aspects, the Super Science Initiative did not provide funding for a facilitation process. This meant that the kind of consultation and negotiation that in the case of NCRIS would have preceded a decision as to the location of a new facility was not able to occur. In some cases, this has led to pressure on identified hosts of infrastructure to find significant co-investment after the announcement of the Super Science funding.

Project Planning

Project planning involves putting in place the elements required for successful completion of the project. Many elements are required before a project is properly commenced, including: verified project costing estimates; setting up appropriate governance and administrative support; planning approvals; and commitment to co-investment and ongoing support from host institutions and others. Proper project preparation and planning influences not only the establishment or construction phases of a project, but also contributes to the project's long-term outcomes.

Many excellent research infrastructure projects, particularly at the national and landmark scale, may not come forward in a project-ready state. The creation of excellent research infrastructure facilities requires careful and rigorous planning and consultation. This planning needs to be funded somewhere in the system.

[31] *NCRIS Evaluation Report*, June 2010, p 30.
[32] *NCRIS Evaluation Report*, June 2010, p 28.
[33] *NCRIS Evaluation Report*, June 2010, p 30.

The *Strategic Roadmap 2006* identified priority capability areas where investment would benefit Australian science. Once a capability was identified and a funding envelope agreed, a facilitator, paid for from NCRIS funds, was engaged to consult with the relevant community and develop an investment plan for the creation of a research infrastructure capability for consideration by the NCRIS committee.

Approved investment plans were developed into project plans that were incorporated into funding agreements. These plans usually incorporated the requirement for annual business plans to allow for some flexibility in the implementation of the project as it evolved over time. This approach of roadmapping to determine priority areas for development, followed by facilitation and consultation to achieve project plan development was strongly endorsed in the *NCRIS Evaluation Report*.

A complementary approach could be to ensure that some research infrastructure program funding is set aside for approved scoping and project development costs. This is likely to be particularly valuable for large or complex projects, or those involving construction. In a collaborative environment, it is unreasonable to expect a single institution to bear the project development costs for research infrastructure that is national in scale and scope.

Principle – Holistic Funding – Project Planning

- **Funding programs should consider setting aside some funding for project development costs, either for a facilitation-based process or for project development and scoping activities**

Running costs

As identified in the *NCRIS Evaluation Report*, provision of support for skilled technicians to operate research infrastructure is seen as critical to the success of research infrastructure facilities. It allows facilities to provide a high quality service to users, ensures that the infrastructure is used correctly and not damaged by inexperienced users and frees up researchers to do research.

In addition, one element of successful facilities is the capacity to promote the available infrastructure in order to maximise uptake and move towards full utilisation, as well as articulate the value of the research it supports. This outreach role is not covered within the scope of EIF funding but has been a feature of a number of successful NCRIS projects.

A key concern for research infrastructure operators is the need to provide career paths and employment security for skilled staff, particularly where there is uncertainty regarding provision of operating costs.

For local infrastructure, provision of operational support may not be an issue where it is funded by the host institution. However, the funding of governance and other operational costs for national and landmark infrastructure is vital for their future accessibility, utilisation, and viability.

The SRE initiative is providing significant additional support to cover the indirect costs of research. However it is only available to universities. With respect to covering the operating costs of national, collaborative infrastructure, it is problematic to expect a

host institution to allocate its SRE funding to pay to operate infrastructure used by a range of institutions.

It is widely recognised that travel costs are a direct cost of research rather than a component of research infrastructure and as such these costs should not be considered as part of a research infrastructure funding application nor a funding model.

Principle – Holistic Funding – Running Costs

- **Funding programs should be able to support all aspects of research infrastructure including, in addition to capital costs, funding for governance, skilled technical support staff, operations and maintenance.**

Depreciation

In general, Australian research infrastructure funding programs have not funded depreciation. The NCRIS Committee, for example, considered that where institutions such as Australian Government departments were required to set aside cash to cover their depreciation expenses, they should have to ensure they were able to meet those expenses before taking on ownership of NCRIS funded assets.

Any proposal to provide funding support for depreciation would impact negatively on the funding available for research infrastructure, diluting the amount of funding available for the creation, development and operation of new infrastructure.

It should be noted that depreciation is not an allowable indirect cost in the context of the SRE initiative.

There is a separate issue regarding the treatment of depreciation in Australian Government agencies, as distinct from funding programs, which has not been considered in this framework.

Principle – Holistic Funding – Depreciation

- **Depreciation for research infrastructure facilities should not be funded by Australian Government funding programs.**

Prioritisation

As a mid-sized economy and in a tight fiscal environment, Australia needs to prioritise its investment in research infrastructure and consider its priorities in both a national and an international context.

Powering Ideas recognised the central role of prioritisation in achieving successful investment in Australia's innovation system, suggesting that this be a rigorous program undertaken in conjunction with careful planning and close collaboration with

stakeholders[34]. Australia's capacity to invest in research and research infrastructure must be considered in the context of its modest resource base.

The most commonly used measures of research capacity are gross expenditure on research and development (GERD)[35] relative to Gross Domestic Product (GDP) and population. Australia's GERD is currently 2.06 per cent, ranking twelfth among the thirty OECD countries[36].

Australia's R&D expenditure directly funded by its governments at all levels stood at only 0.77 per cent of OECD R&D expenditure in 2006[37].

Purely in terms of scale, Australia cannot expect to match the research infrastructure capabilities of larger countries.

Australia should prioritise investments in research infrastructure to ensure the needs of the nation and its best researchers are met. This means prioritising investment based on excellent research, or areas in which Australia seeks to develop leading research capability. Any consideration of research excellence also needs to be balanced by a focus on innovation outcomes and the contribution that research makes to productivity and prosperity.

One of the principles underpinning the NCRIS program was that:

> Infrastructure resources should be focussed in areas where Australia is, or has the potential to be, world-class (in both discovery and application driven research) and provide international leadership.

Subsequent discussion regarding prioritisation of requirements and investment in research infrastructure has strengthened this principle, particularly in an environment where the ERA framework will provide significant new data with which to make objective assessments of research quality and relative research strength in Australia's higher education institutions[38].

ERA will not evaluate research undertaken within CSIRO, other Publicly Funded Research Agencies and industry. However some of these organisations have developed their own approaches to evaluating research and priority setting.

There are important international dimensions to national priority setting. First, priorities set by competitors or partners have direct and indirect impacts on national priority setting exercises. The most direct impact is via the competition among researchers themselves in the creation and discovery of new knowledge. Strength in knowledge production in one country – specialisation – can influence the direction of specialisation in another country with different financial and intellectual endowments.

Foreign funding for research via multinational or public research organisations may also have an indirect impact on the direction of research in the receiving country by signalling user demand in a given area[39].

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[34] *Powering Ideas: An Innovation Agenda for the 21st Century* 2009, p 53.
[35] The most commonly used measures of research capacity are gross expenditure on research and development (GERD) relative to GDP and population. *Australian Innovation System Report 2010*, p 30.
[36] *Australian Innovation System Report 2010*, p 30.
[37] The general Government sector comprises all Government units of the Australian Government, State and Territory Governments and each Local Government authority, as all resident non-market, non-profit institutes (NPIs) that are controlled and mainly financed by those Governments. The scope of the ABS R&D survey in the Government sector is based on the OECD definitions, including organisations such as CSIRO, ANSTO and Geoscience Australia.
[38] The Excellence in Research for Australia (ERA) Initiative homepage www.arc.gov.au/era
[39] OECD Priority Setting for Public Research Challenges and Opportunities, 26-27 October 2010, International dimensions of priority setting para 47 p 16.

One example of our ability to attract inward international investment is the CSIRO management of the USDA laboratories in Australia (part of their global network). CSIRO is paid to undertake this role which came about through Australia's long term relationship with the USDA as well as research strengths in particular areas and experience in managing facilities of this scale.

It is also important, when identifying priority infrastructure requirements for Australian researchers, that access to international infrastructure is considered as an option for Australian researchers. In some cases, this will be the only way Australian researchers can access specific facilities; in others, it may be more cost-effective than buying or building infrastructure in Australia. This will frequently be the case where there is a relatively small number of researchers in Australia who need access to particular facilities and the cost of building the relevant infrastructure in Australia is high. Given the opportunity costs in such a scenario, enabling access to overseas infrastructure needs to be considered as part of a process to prioritise research infrastructure.

There has been some criticism that the system of identifying research infrastructure requirements to date has been biased towards hard physical infrastructure as opposed to information infrastructure, collections and the kinds of datasets that underpin much research in the Humanities, Arts and Social Sciences (HASS) sector.

Roadmapping as a tool to determine priorities for research infrastructure investment

The purpose of developing a roadmap is to inform decisions on where Australia should make strategic infrastructure investments to further develop its research capacity. Specifically, what infrastructure should be prioritised in Australia and what overseas infrastructure should be prioritised for access.

The roadmapping process involves structured and strategic consultations with stakeholders across the research sector. Initially, expert working groups are established to provide specialist advice. Following this there is broad dissemination of a discussion paper seeking sector input with responses feeding into the development and release of an exposure draft of the roadmap for further comment.

Extensive stakeholder consultations are undertaken throughout the process to ensure that the information obtained clearly articulates what research is important and what capabilities are needed to support that research.

The investments made under NCRIS were informed by a consultative process that resulted in the *National Collaborative Research Infrastructure Strategy Strategic Roadmap 2006*. This Roadmap was revised and updated through renewed consultations that informed the *Strategic Roadmap for Australian Research Infrastructure 2008*.

Both the *Review of the NCRIS Roadmap and Facilitation Processes 2007* and the NCRIS Evaluation strongly supported roadmapping. Some Australian jurisdictions (such as South Australia) have undertaken roadmapping exercises, demonstrating its usefulness in a range of settings. Roadmapping has also been used extensively overseas to support strategic decision-making around research infrastructure priorities.

It is therefore recognised that roadmapping is an integral part of prioritisation of research infrastructure investment areas, and it is proposed that regular revisions of the national strategic roadmap be undertaken.

However, the proposed framework principles do not intend to be prescriptive regarding such activities in order to retain flexibility and to ensure that priority-setting tools can be tailored to specific situations and varied over time.

National Research Priorities and National Innovation Priorities

The National Research Priorities (NRPs) were introduced in 2002 and were designed to focus the Australian Government's research effort into those areas that can deliver significant economic, social and environmental benefits to Australia.

The NRPs were last reviewed in 2007. Consideration is currently being given to the scale and scope of a possible future review.

The current National Research Priorities are:

- An environmentally sustainable Australia;
- Promoting and maintaining good health;
- Frontier technologies for building and transforming Australian industries; and
- Safeguarding Australia.

The National Innovation Priorities (NIPs) identified in *Powering Ideas* complement Australia's NRPs; combined these help focus public-sector research[40]. The NIPs are broad priorities aimed at promoting collaborative relationships between research and industry. The prioritisation principles proposed in this discussion paper would allow current, applicable research priorities to be used to inform investment decisions.

A full listing of the NIPs is available at:
http://www.innovation.gov.au/AboutUs/KeyPublications/PortfolioFactSheets/Documents/POWERING-IDEAS.pdf

The NRPs were used in the 2006 roadmapping exercise as an organising principle on which to base the Expert Working Groups. Each group examined the strategic requirements related to each of the NRPs in the context of the advice received in consultations and submissions.

For the 2008 Roadmap, it was decided to base the Expert Working Groups on the NRPs again and include two additional areas identified for specific consideration – HASS and Information and Communication Technology (ICT). Six expert working groups were therefore utilised for the 2008 roadmapping exercise. The NRPs have been used in this way to enable some focus on broad research areas without seeking to be prescriptive about research that may cross multiple NRPs and be of interest to several working groups.

Moving from identifying capabilities to defined investments

Once investments have been prioritised, particularly in the national, collaborative research infrastructure category, it is important that a consultative process follows to determine the best location, operating and governance arrangements to support the required research infrastructure. There are a range of factors which could inform

[40] Commonwealth Parliamentary Debates (Hansard), House of Representatives, 5 December 2002, pp. 9751-9752; Australia's National Research Priorities: The national Research Priorities and their Associated Priority Goals (Canberra: Department of Education, Science and Technology, 2003).

decisions in relation to location. There are a number of potentially world-scale innovation precincts emerging in the Australian environment which are built around large numbers of researchers, significant infrastructure and access to high speed communications and high end computing. Consideration could be given to locating research infrastructure in these precincts.

The consultation could take the shape of a facilitation process, as was used in NCRIS, or some other arrangement. There is value in consultation and negotiation preceding a final decision, to ensure co-investment is identified and taken account of and suitable collaborative arrangements can be put in place.

Principles – Prioritisation

- **Prioritisation of investment in research infrastructure is necessary to ensure appropriate, effective and efficient investment and to support strategic decision-making with regard to national and landmark infrastructure.**
- **Any proposed infrastructure investment should align with and support Australia's research, innovation and infrastructure priorities.**
- **Funding for Australia's research infrastructure should focus on areas where Australia:**
  - **undertakes world-leading research or innovation;**
  - **has demonstrated a particular strength in international terms; or**
  - **has reasons to seek to strengthen capacity in an area of research or innovation.**
- **Processes for funding research infrastructure should be transparent, provide effective use of funds and target intended outcomes.**

Question 1: The proposition is to undertake a roadmapping exercise every three years. Are there reasons why it should be more or less frequent?

Question 2: Are there other prioritisation processes that should be included in the Strategic Framework?

Excellence in research infrastructure

As researchers increasingly come to rely on research infrastructure, ever higher levels of service will be expected. In order to secure continued funding, facilities will need to demonstrate high levels of professionalism – indeed, excellence – in the delivery of their services.

Australia has demonstrated that it can produce world-beating innovations, but it is becoming increasingly difficult to compete internationally. As recognised in *Powering Ideas*, a stronger innovation system is needed to support jobs and growth and to build skills and research capacity. As one of the key inputs aimed at generating a stronger innovation system, research infrastructure must be developed so that it supports and enables excellence. It should therefore aim to be world-class, if not world-leading, and

it should aim to foster excellent, world-class research for all scales of infrastructure investment.

In addition to supporting excellent research (as discussed in the previous section on prioritisation), research infrastructure also needs to be constructed, implemented and operated in a professional manner. As research becomes more specialised and more dependent on high-end equipment, from microscopes and sensors to databases and real-time visualisation tools, such equipment needs to be reliable, predictable, available and very high quality.

An understanding of excellence may be achieved by community consultation and through the development of a collaborative proposal that incorporates and includes leading research infrastructure providers, such as through the use of a facilitation or collaborative strategic planning process like that used to develop investment plans for medium to large-scale national infrastructure under NCRIS.

Collaborative proposals could then be evaluated by an expert committee such as NRIC, perhaps assisted by external referees or expert panels where appropriate. For smaller scale, local infrastructure, a competitive process incorporating peer review to determine the relative merit of proposals may be more appropriate.

Given the potential breadth of research endeavour and the need to try different approaches to the creation and development of research infrastructure, it is proposed that the Strategic Framework does not attempt to spell out criteria for the assessment of excellence for each approach or for each category of research infrastructure.

However, it is expected that any program for funding research infrastructure will have well defined elements that ensure that a commitment to excellence is a prerequisite for investment.

Reviews and evaluation of investments

Evaluation of programs is integral to the determination of successful outcomes; an evaluation process needs to be built into any and all research infrastructure investment programs in the future.

Over time, research infrastructure facilities will be more or less successful in terms of providing services to researchers. This needs to be documented to capture and promulgate lessons for future activities. Proper evaluation also helps determine whether an investment has delivered the desired outcomes, achieved its objectives, and whether public funds have been used effectively, as well as highlighting the value generated by the research infrastructure and the resulting research over the medium to long term.

The recent *NCRIS Evaluation Report 2010*, for example, highlighted performance evaluation and monitoring of research infrastructure investments as a key area for improvement, and suggested regular web-based reporting against agreed performance indicators.

For landmark infrastructure, it is appropriate to set out the appropriate evaluation and performance monitoring criteria and this is addressed in the advice relating to landmark research infrastructure that NRIC has provided to the Minister.

Principles – Excellence in research infrastructure

- **Proposals for investment in all scales of research infrastructure should be evaluated on the basis of their ability to create excellent or world-class infrastructure.**
- **Research infrastructure funding programs should incorporate procedures for regular and rigorous evaluation of funded infrastructure to determine whether the infrastructure has delivered the desired outcomes and achieved its objectives over the short and medium term, as well as over its whole life-cycle.**

Collaboration

Collaboration is a key driver of innovation. Collaboration stretches our research dollars further, spreads risk, favours serendipity, propagates skills, builds critical mass and leads to outcomes that have broad relevance.

In *Powering Ideas*, the Government set a goal of doubling the level of collaboration between publicly funded research agencies and business over the next decade.

As Minister Carr remarked at the recent research infrastructure forum, this collaboration will be critical to ensure the research community can deliver the knowledge and skills our growing industries need.

The need for and value of collaboration in research is increasingly acknowledged. The proportion of Australian publications in the Science Citation Index with international co-authorship has increased from almost 21 per cent in 1991 to over 44% of total publications in 2005. The output of internationally collaborative papers is growing at almost double the rate of purely domestic papers[41].

Modern research is often complex, multidisciplinary and requires collaborative effort. In many disciplines it is no longer the case that a single researcher can collect and analyse all the data that relates to their research topic – collaborating with others to share data and bring different perspectives to bear on complex problems is becoming necessary.

A key piece of feedback from participants in the NCRIS and Super Science programs has been to reinforce the distinction between collaborative – or shared – approaches to the provision of infrastructure and research collaboration.

For instance, collaboration in the construction and operation of research infrastructure – as in the case of the National Computation Infrastructure based at the Australian National University (ANU) and operated by ANU and a range of partners including CSIRO, Bureau of Meteorology, Intersect and others – is a separate and valuable proposition to collaborative research. One can occur independently of the other and both generate advantages in the research system.

They are not the same, but they are both important. And in the context of finite resources, the Government has a stated preference for promoting and enabling collaborative research, including international collaborations. On this basis, future funding programs are likely to build in some requirement for collaboration in one or both of these aspects.

[41] http://www.feast.org/index/document/1, pg 4.

In addition, as noted in the *Strategic Roadmap for Australian Research Infrastructure*[42], there are economic and efficiency arguments for taking collaborative approaches to establishing and operating research infrastructure to enable world-class research. In many cases, single institutions cannot achieve the levels of research infrastructure needed to support such research on their own. It makes economic sense for the Australian Government, universities, State and Territory Governments, research institutions and business to cooperate in implementing these research infrastructure investments.

NCRIS was ground-breaking in its requirements for a national collaborative focus on research infrastructure. At a smaller scale, LIEF generally funds projects that include multiple, collaborating parties with shared requirements. These approaches should ensure greater effectiveness of investment and value for money for the research sector.

For research infrastructure in the national and landmark categories the expectation is that collaboration, in the development, operation and/or use of research infrastructure, would be an essential element of any project.

Principle – Collaboration

- **Funding should favour investments that demonstrate collaborative approaches for the creation, development and operation of research infrastructure and/or that foster a collaborative research culture.**

Question 3: Should Australian Government investment in research infrastructure at the national and landmark scale favour collaboration in establishment and operation of infrastructure or research collaboration, or both?

Co-investment

Current and past research infrastructure funding programs have required differing levels of co-investment as a condition of Australian Government funding. Mandated requirements for co-investment have ranged from zero (NCRIS and the Super Science Initiative), 25 per cent (ARC's Linkage Infrastructure, Equipment and Facilities program[43]), to 50 per cent and beyond (Major National Research Facilities program[44]).

A requirement for matching funding was seen as one of the limitations of the MNRF program.

Although the NCRIS program carried no formal requirement for co-investment, as noted in the *NCRIS Evaluation Report*, over the program as a whole 42 per cent of the funds were provided by NCRIS while 30 per cent were from cash co-investment and the balance from in-kind co-investment. Thus, although there was no mandated requirement for co-investment, substantial leveraging of public money was achieved and the benefits maximised. In some instances, the preparedness of State

[42] Australian Government, *Strategic Roadmap for Australian Research Infrastructure*, 2008.
[43] *Australian Research Council Act 2001*. Linkage Infrastructure, Equipment and Facilities Funding Rules for funding commencing in 2011 Variation (No.1).
[44] MNRF Program FAQ. www.dest.gov.au

Governments and institutions to co-invest in NCRIS capabilities influenced their ultimate location and was a factor in deciding how they would be implemented.

Co-investment shares the cost and risks of establishing and operating infrastructure and also represents a tangible demonstration of participants' priorities. Even if the original source of an institution's co-investment was Government funds, it is still a significant indication of commitment for discretionary monies to be directed to support research infrastructure.

Flexibility in requirements for co-investment over time has been shown, in the case of NCRIS, to increase the capacity to leverage the Australian Government's investment. This is particularly the case where State Government budget cycles enable State contributions in later years of a project but not upfront.

In any future research infrastructure funding programs, if State or Territory Government co-investment is likely to have an impact on decisions as to which infrastructure to support or where to locate it, it would improve transparency – and likely improve the level of co-investment on offer – if that were understood by stakeholders and articulated clearly.

Such an approach would also be likely to improve coordination between the States and Territories and the Australian Government with regard to research infrastructure investment, as would greater continuity and predictability of funding programs.

An important lesson from NCRIS was that allowing flexibility for State and Territory Governments to deliver on their co-investment commitments over time encouraged greater overall leverage than would have been achieved by requiring co-investment up-front.

Principle – Co-investment

- **Co-investment in research infrastructure is desirable as it demonstrates a commitment by the investing party/ies to the project. Some co-investment is therefore desirable but no specific requirement for co-investment should be stipulated at the framework level.**

Access

Australian-based infrastructure

Powering Ideas noted that exposure of Australian firms to global markets and supply chains increased both the necessity and the opportunities for innovation. The demands of international competition have compelled outward-looking firms to achieve high levels of creativity and productivity. Such concepts are equally applicable to research and research infrastructure.

Access regimes should provide for infrastructure to be broadly available to researchers across Australia on the basis of merit. A benefit of direct Australian Government investment in national, collaborative infrastructure is that access regimes are able to be built in as part of the conditions of funding.

There are many illustrations of the need for and benefits of globalisation of research infrastructure: in sciences such as astronomy through the provision of access for

researchers to jointly operated international observatories requiring multinational investments; via data sharing in sciences with global impact such as marine and climate science; and in developing international excellence in research outcomes via the fostering of international collaboration.

One of the challenges for Australian science is ensuring that all available research infrastructure is put to optimum use, and that any under-utilised infrastructure is made more widely available. Research infrastructure established under NCRIS was required, as a key criterion for funding, to be made available to public researchers at no more than marginal cost, and to private researchers on a cost-recovery basis. The Super Science Initiative has also applied this requirement.

Questions regarding access to data and knowledge infrastructure also need to be taken into account, as more of the inputs to research are the outputs of other research, and of broader data-gathering exercises for government or private purposes. Addressing barriers to the access, sharing and re-use of data, including intellectual property regimes and institutional firewalls, is important when considering access to research infrastructure, just as physical access to facilities is important.

While accessibility to national and landmark research infrastructure to public researchers on the basis of merit is a key element that should be maintained, there are some instances, for example in local infrastructure, where universal access may not be possible or desirable. However, the overall availability of similar types of research infrastructure should be considered when determining the most appropriate access regimes.

Given the expectation of wide access for researchers of merit, NCRIS capabilities have needed to put in place processes to ensure their infrastructure is accessible.

Different capabilities have taken slightly different approaches to this issue, depending on the nature of their infrastructure. The Integrated Marine Observing System, for example, has agreements in place about the access to and use of the data being collected from the various instruments, for example, whereas in the case of the characterisation capabilities, access means using an instrument, rather than rules for the use of data.

In some cases, the use of research infrastructure has a clear cost for a particular use and that cost cannot be absorbed by the operators of the infrastructure. In these instances, the cost of access for public researchers must be met somewhere in the system. Options include provision of funding to the research infrastructure facility to subsidise free access, or provision for funding access as part of research grants.

In NSW, for example, a system of TechVouchers is providing a direct subsidy to encourage use of infrastructure and participation by researchers in the broader innovation system.

NSW Case Study

TechVouchers
Announced in late 2009, the TechVouchers program is a $1.6 million NSW Government pilot project designed to encourage collaboration between NSW small-to-medium enterprises (SMEs) and public sector research organisations (PSROs) located in NSW.

The TechVoucher program has two funding components:

1. **TechVouchers** – a voucher system that provides eligible SMEs with up to $15,000 to fund access technical expertise or equipment and support collaboration with PSROs in NSW; and

2. **Connectors** – up to $50,000 in TechVoucher Connector funding to NSW PSROs to fund part of the salary of a suitable experience person to manage the relationship between the research organisations and SMEs, and increase industry access to the research capabilities and infrastructure on offer

Nine Connectors have been appointed through the program including the University of Sydney, CSIRO, University of Newcastle, Macquarie University, University of Wollongong, University of Technology, Sydney, Southern Cross University, NSW Institute of Sport and the Australian Nuclear Science and Technology Organisation (ANSTO).

Principle – Access to Australian-based infrastructure

- **Research infrastructure at the national and landmark scale should be made widely accessible to publicly funded researchers on the basis of merit at no more than marginal cost.**
- **Research infrastructure in the externally supported or local category should be made accessible to the extent possible in order to maximise use and support collaboration between institutions.**

Overseas-based infrastructure

Provision of the most appropriate research infrastructure may not always require the construction of facilities in Australia. In some instances, the most appropriate way to support researchers is to support their access to large, sophisticated facilities that are located overseas. In some cases it may be appropriate for Australia to contribute to these multinational facilities to gain benefit for Australian science.

Given that upwards of 97% of global research output, in the form of research publications, is produced in other countries[45], Australia cannot afford to isolate itself from access to that research, and use of overseas research infrastructure is one way to establish communities of interest, research collaborations and mutually beneficial arrangements.

[45] *Australian Innovation System Report 2010*, p 30

Principle – Access to overseas-based infrastructure

- **Research infrastructure funding programs should consider requests for funding Australian researcher access to overseas facilities, and, where appropriate, Australian membership of or contribution to the construction of overseas facilities.**
- **Where possible, research infrastructure facilities should be encouraged to provide overseas access to Australian research infrastructure to foster international links and collaborations and build local skills.**

Question 4: Where in the system should the costs of access to research infrastructure for public researchers be met? How should this be implemented?

Pricing

The cost of using research infrastructure is a separate though related issue to who should be able to access the infrastructure. There is also a strong relationship between pricing and holistic funding principles.

The Major National Research Facilities (MNRF) program required funding recipients to develop a plan to become self-sustaining by the end of their funding allocation. However, most recipients of MNRF funding did not successfully make the transition from being publicly funded to self-supporting. While it may be possible for a research infrastructure facility to become self-supporting in the long-term, in the short to medium term, this goal has been seen to be unrealistic.

There can also be negative consequences in terms of usage, viability of facilities and accessibility if too much emphasis is placed on financial independence. In general, the measure of success for research infrastructure should be the research outcomes, not the ability to move to a self sustaining pricing model.

Case Study

Cost (Non)-Recovery by Platform Technology Facilities in the Bio21 Cluster

Platform technologies (PT) are techniques or tools that enable a range of scientific investigations and are critical to today's advanced technology research environment. Once installed, they require specialised staff for their operations, who in turn provide expertise to researchers in designing appropriate experiments. Through this pipeline, research outputs are raised to the benefit of the researcher and the host institution[46]. Platform facilities provide access to instrumentation and expertise for a wide range of users beyond the host institution, including other academic and industry users. To maximise return on these substantial public investments, this wider access needs to be supported. The question of support and the mechanisms through which this occurs need to be established based on greater understanding of how PT facilities operate. This investigation was aimed at understanding if and how platform facilities across the Bio21 Cluster meet operating costs. Our investigation found: 74 per cent of platforms do not recover 100 per cent of direct operating costs and are heavily subsidised by their home institution, which has a vested interest in maintaining the technology platform; platform managers play a major role in establishing the costs and pricing of the facility, normally in a collaborative process with a management committee or institutional accountant; and most facilities have a three-tier pricing structure recognising internal academic, and commercial clients[47].

Australian research facilities aspire to conduct research that is the equal of the best in the world. This implies that the facilities must commit to providing the highest standards of service, and must ensure that these facilities are adequately resourced. Any attempt by a facility to deliver the highest quality facility and research at 'bargain basement' prices is flawed in both economic and policy terms.

Pricing is an important issue for researchers, particularly where access to a particular facility is not available for free, regardless of merit. The 2010 NCRIS Evaluation noted that the responsibility for covering the cost of access to research infrastructure for public researchers is unclear and needs to be resolved.

There are at least two ways of approaching this issue:

- Provision of funding to research infrastructure facilities to subsidise free or marginal cost access; or
- Provision for funding access as part of research grants.

Research infrastructure projects established under NCRIS were required, as a key criterion of the funding, to be made available to public researchers at no more than marginal cost, and to private researchers on a cost-recovery basis. The Super Science Initiative has also applied this requirement.

[46] Angeletti RH, Bonewald LF, De Jongh K, Niece R, Rush J, Stults J. *Research technologies: fulfilling the promise*. FASEB J 1999; 13:595-601.
[47] Gibbs G, Clark S, Quinn JA, Gleeson MJ. *Cost (Non)-Recovery by Platform Technology Facilities in the Bio21 Cluster*. Journal of Biomolecular Techniques 2010 21:29-34

In advice to the facilitators for the NCRIS capabilities, the department defined marginal cost in the following way:

> Marginal cost represents the cost of accommodating one additional user at the facility. In most instances, this will equate to the avoidable costs related to that extra user, such as consumables and any additional support staff.

A key feature of NCRIS that enabled this requirement is the program's ability to fund the fixed operating costs.

The price for access to a research facility should be transparent and take into account a comprehensive analysis of direct and indirect costs to unsure these are understood and a full understanding of what price would represent acceptable value to the researcher. Pricing policies should recognise that the objective for most publicly funded research infrastructure is to maximise the public benefit.

The most appropriate pricing model will vary from facility to facility based on a number of factors including the cost of consumables, the actual cost of using the infrastructure and the level of government funding. The pricing policy for a facility should also be able to accommodate different pricing structures for different users, such as being able to charge commercial users the full cost of using the infrastructure.

Above all, pricing policies adopted for publicly funded research infrastructure should ensure meritorious research is not priced out of the market.

Principle – Pricing

- **Pricing policies for research infrastructure should be transparent and allow for flexibility in the charging model, while still maximising the public benefit.**
- **Publicly funded researchers should be charged no more than the marginal costs of using publicly funded research infrastructure.**

Question 5: How should the pricing regime for research infrastructure be structured? Should there be different models for financial contributors to the facility, merit-based researchers and industry?

Question 6: How should the cost of access by publicly funded researchers be funded?