NCRIS
National Research
Infrastructure for Australia
An Australian Government Initiative

National Research Infrastructure Census

REPORT
(2015-16, 2016-17)

Wallis strategic market & social research

Wallis Reference WG4554 | July 2018

Report prepared for:

Research Policy and Programs Branch
Research and Economic Group
Commonwealth Department of Education and Training

Wallis Market and Social Research achieved accreditation to the International Standard ISO20252 in September 2007. The Company is committed to maintaining administrative and operational procedures which comply with these accreditation requirements and to improving its performance in all aspects of the service it delivers to its customers.

Wallis is an active participant in the market research industry, with senior staff making significant contributions to the Australian Market and Social Research Society (AMSRS) and the Association of Market and Social Research Organisations (AMSRO). As such we actively pursue the ethical objectives of the industry.

In addition to having attained the highest Industry accreditation, Wallis also participates in the Australian Achiever Awards, which recognises the customer service excellence of Australian companies. The Company has been awarded a high commendation every year since the inception of these awards in 1999.

Wallis is an acknowledged leader in data protection and privacy. Our systems are OWASP certified and we are Privacy Awareness Week partners – committed to sharing our knowledge with others.

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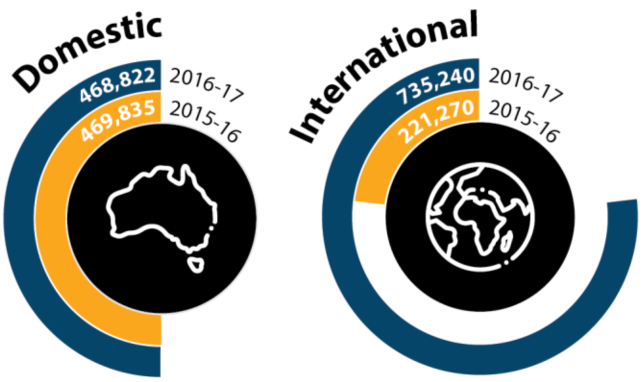
2015-17 NCRIS Census Snapshot

Early 2018, Wallis Market and Social Research undertook a census of National Collaborative Research Infrastructure Strategy (NCRIS) projects, on behalf of the Department of Education and Training. The census covered a reference period of two financial years: 2015-16 and 2016-17. The census collected data on usage of NCRIS facilities, and the resulting impacts. It also gathered data on the operation of NCRIS facilities, including both physical infrastructure and human resources. This page outlines some of the key metrics uncovered, while further detail is contained in the subsequent report.

USAGE OF NCRIS FACILITIES



LEVERAGING INVESTMENT

In **2015-17** every **$1.00** of government investment yields

$1.00

$0.28 in cash and **$0.60** in-kind investment from other sources

$0.28

$0.60

A total of **$0.88**

$0.88

IMPACTS

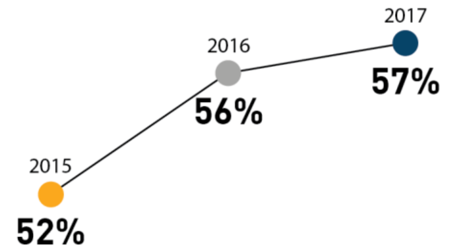
5,700

Citations from NCRIS-enabled Research

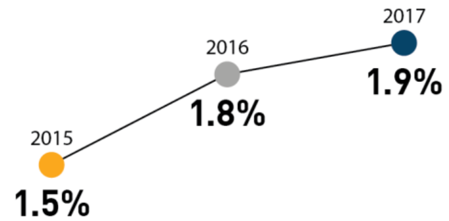
Field-Weighted Citation Impact

2015	1.88
2016	1.85
2017	2.07

International Collaboration



Corporate Collaboration



Data based on submitted lists of NCRIS-enabled publications

STAFFING

1,975

Total Staff

79% Technical Staff

12% Managerial Staff

9% Admin/ Support Staff

1 in 4

staff are female

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Wallis

2.0 Introduction

2.1 Purpose of the Project

The Australian Government Department of Education and Training is tasked with providing an aggregated and detailed picture of how National Research Infrastructure (NRI) supports quality research that benefits Australia.

This exercise is an attempt to gather an overall, system-wide picture of Australia's NRI: its scope, scale and reach. It is not an objective of this census to compare projects with one another.

Within the broader network of NRI, particular focus is applied to National Collaborative Research Infrastructure (NCRIS) projects. This report presents the aggregated data from across NCRIS projects.

2.2 Overview of the Census

The census has two reference periods: the 2015-16 and the 2016-17 financial years, with respondents requested to fill out a single form containing both reference years.

The census was undertaken across the full range of NRI that was considered during the development of the 2018 Research Infrastructure Investment Plan. Given that projects vary massively in terms of size, purpose, scope and structure, it should be understood that some of the questions may not have been equally relevant to all NRI facilities and contexts, and that NRI facilities cannot always be sensibly compared on all metrics.

With regard to NCRIS projects, of the 26 projects invited to participate, 24 of these completed the survey. One project was ceased in 2017-18 and was not able to provide data in time to support the census as a result of reduced resources. Another NCRIS project, the European Molecular Biology Laboratory Australia, did not have any Australian based infrastructure, and so was exempt from completing the census.

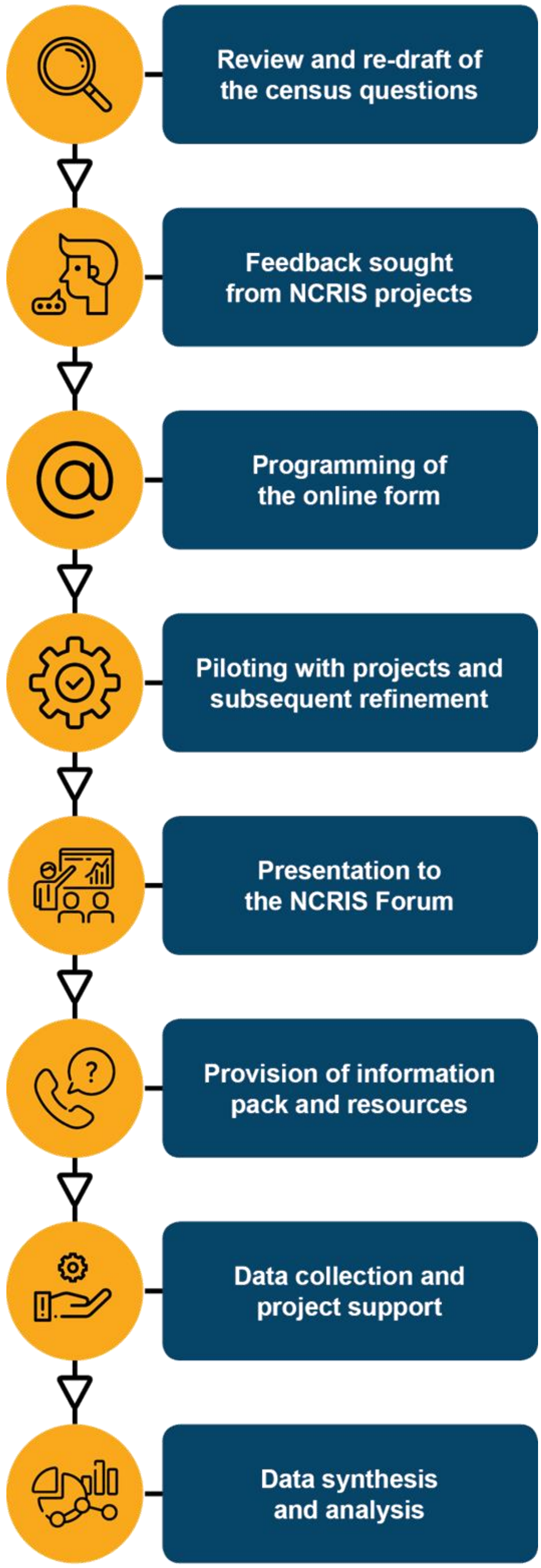
A list of all NCRIS projects that were invited to the census, as well as their completion status, is included in Appendix 2.

One NCRIS project, Research Data Services (RDS), completed the survey via a different form for each node as well as the head office (a total of 8 forms). These forms were then merged together to represent a single project for the purpose of this report. On the other hand, Australian Nuclear Science and Technology Organisation (ANSTO) National Deuteration Facility and ANSTO Nuclear Science Facilities (NSF) completed separate forms and are treated as separate projects for the purpose of this report.

2.3 Methodology

The approach to the project is shown below:

Figure 1 NRI Census Methodology overview



The first step in the methodology was a thorough **review and redraft** of the census questions. The Department provided the results of its internal consultations, which revealed priority areas for consideration. These were then assessed alongside the existing census instrument that had been used in 2015.

Once a draft census form was agreed between Wallis and the Department, it was shared (in MS Word form) with a small number of NCRIS projects. **Feedback was received and incorporate**d into the next version of the census form.

Wallis then **programmed the census** form to allow online completion by projects.

The form was shared with a pilot sample of volunteer projects, and final feedback was received, evaluated and incorporated.

Wallis **presented to the NCRIS Forum** in Canberra, informing projects of the upcoming census exercise.

Prior to the commencement of fieldwork, census participants were sent an **information pack**. The information pack consisted of a glossary, a FAQ document, a list of survey sections, and a PDF of the full census form in order to help respondents prepare the information they would need ahead of the fieldwork period. Projects were also followed up via email and telephone to broach the project census and its requirements.

The finalised **data collection** was undertaken primarily with the use of an online form, as well as being supplemented by Excel templates. The online form was open from March 27th 2018 and remained open until May 21st 2018.

For the question concerning lists of publications, participants submitted these via an Excel template. Participants were also able to submit additional questions (e.g. lists of financial co-contributors) via Excel templates if they preferred this over using the online form. The projects received ongoing telephone and email support from Wallis.

Once received, **data was collated, sense checked, and analysed**, forming the basis of this report.

3.0 Utilisation of National Research Infrastructure

3.1 Overall Users and Usage

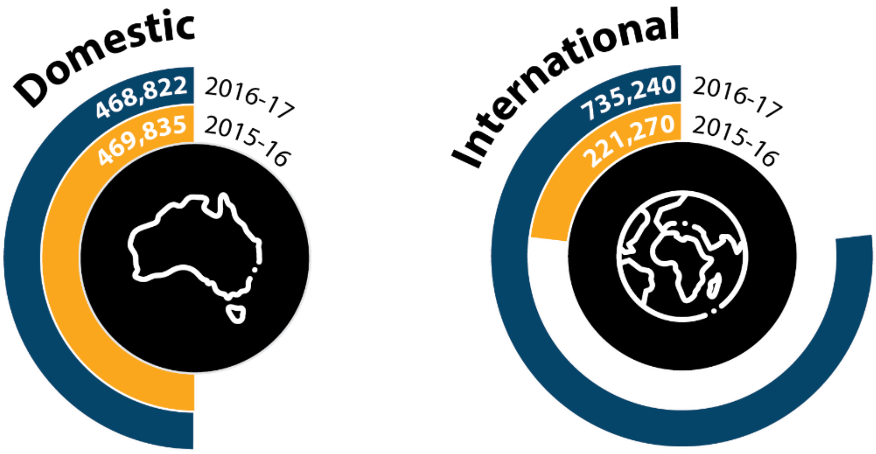
On the census form, participants had the option of either entering their number of users, or alternatively, their number of uses. They also had the option of entering both of these metrics. Participants were directed to decide this based on what was most relevant or appropriate to their project.

Of the 24 NCRIS projects, 21 (88%) of these completed the **users** option, while only 15 (63%) completed the **uses** option.

Total Users – Program wide

The chart below shows that while the number of domestic users has remained stable, the number of international users has more than tripled since 2015-16. This growth has all essentially come from the category 'non-research users', and from a single project, Atlas of Living Australia (ALA). If the growth in International non-research users of ALA were to be excluded, then total NCRIS 2016-17 usage would be practically unchanged since 2015-16.

Figure 2 NCRIS Users, domestic and international across financial years



Excluding 'non-research users' (most of whom are accounted for by the ALA), the most prominent users of NCRIS Infrastructure are researchers from within universities and users from government departments. Users from within universities have increased strongly from 2015-16 to 2016-17, up by more than 5,000 between the two reference periods. On the other hand, users from government departments have contracted by over 2,500 users during the period.

Table 1 Total *users*: By source

	Year	Domestic	International
Researchers from within Universities	2015-16	33,295	12,697
	2016-17	38,939	11,291
Researchers from within Publicly Funded Research Agencies (PFRA)	2015-16	2,118	360
	2016-17	2,078	302
Researchers from within Medical Research Institutes (MRI)	2015-16	581	35
	2016-17	719	48
Researchers from International organisations	2015-16	73	231
	2016-17	120	363
Researchers from industry / commercial organisations	2015-16	958	174
	2016-17	1,277	202
Researchers from within other organisations	2015-16	1,820	1,528
	2016-17	2,200	1,385
Users from government departments (incl. local government)	2015-16	20,058	998
	2016-17	17,484	998
Non-researcher users	2015-16	382,368	189,740
	2016-17	368,019	704,358
Other (further) disaggregation unavailable	2015-16	28,564	15,507
	2016-17	37,986	16,293
Total	2015-16	469,835	221,270
	2016-17	468,822	735,240

A similar broad pattern is identified when ‘uses’ (rather than users’) is examined, with researchers from within universities being responsible for many uses of NCRIS facilities. Unsurprisingly, for some of the projects where ‘uses’ is the most logical metric, it is not possible to capture details on the individuals making such use, hence the high number of uses that are not possible to disaggregate. These typically came from computational or data services based projects such as Australian National Data Service (ANDS), National Computational Infrastructure (NCI) (responsible for some 89.4 million of the uses that could not be disaggregated) and RDS.

Other than the dramatic increase in domestic uses that could not be disaggregated experienced by NCI, there were some noticeable changes in uses experienced by the National eResearch Collaboration Tools and Resources project (NeCTAR). These included a sharp increase in domestic uses by researchers within *other* organisations, and a significant fall in the number of uses by researchers from within universities.

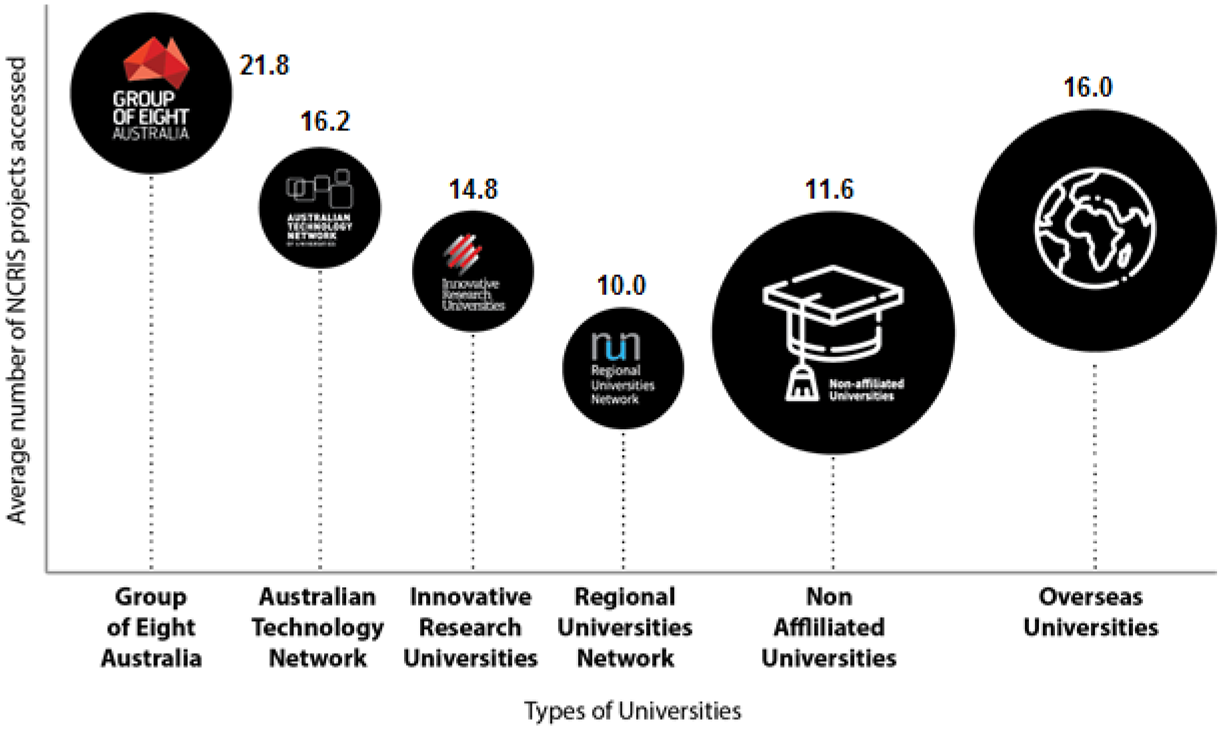
Table 2 Total *uses*: By source

	Year	Domestic	International
Researchers from within Universities	2015-16	199,458	20,122
	2016-17	155,817	24,450
Researchers from within Publicly Funded Research Agencies (PFRA)	2015-16	22,747	3,915
	2016-17	29,163	13,050
Researchers from within Medical Research Institutes (MRI)	2015-16	26,636	5,219
	2016-17	35,903	10,085
Researchers from International organisations	2015-16	70	5,506
	2016-17	49	11,034
Researchers from industry / commercial organisations	2015-16	9,769	2,463
	2016-17	14,850	7,821
Researchers from within other organisations	2015-16	10,297	-
	2016-17	74,662	-
Users from government departments (incl. local government)	2015-16	5,795	-
	2016-17	14,233	-
Non-researcher users	2015-16	457	-
	2016-17	303	11,091
Other (further) disaggregation unavailable	2015-16	9,658,253	3,802,996
	2016-17	89,609,517	1,660,897
Total	2015-16	9,933,482	3,840,221
	2016-17	89,934,497	1,738,428

3.2 Types of Users

The figure below shows how many of the NCRIS projects on average had their facilities used by various categories of universities. To illustrate, on average, about 21 NCRIS projects provided facilities to users from any given Group of Eight university. In contrast, on average, only about 10 NCRIS projects provided facilities to users from any given Regional Network University. There is a clear correlation, where the higher ranked an Australian university is in terms of research impact, the greater the number of NCRIS facilities that university typically uses.

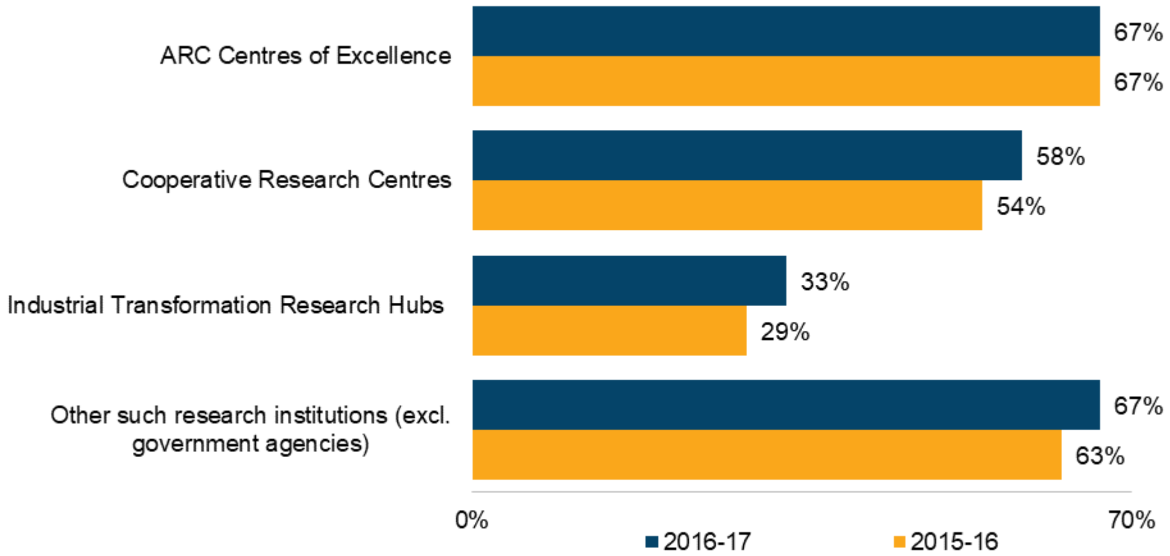
Figure 3 Average number of NCRIS Projects accessed by universities[1]



[1] The size of each bubble in the above chart is proportional to number of universities in the group/network

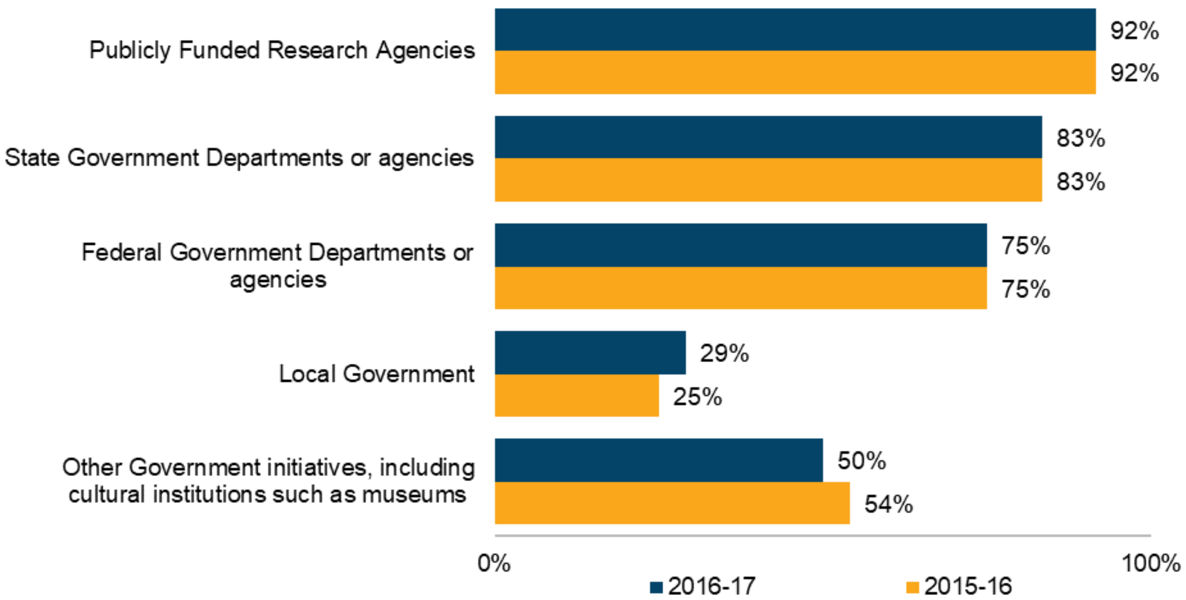
In terms of institutional users, 67% of projects reported that Australian Research Council (ARC) Centres of Excellence used their project's infrastructure.

Figure 4 Types of institutions using NCRIS infrastructure



Over 90% of NCRIS projects reported that Publicly Funded Research Agencies (PFRAs) used their project's infrastructure. Unsurprisingly, State and Federal Government usage was also relatively high (83% and 75%, respectively) compared with Local Government use of NCRIS facilities.

Figure 5 Which Government agencies used your project's infrastructure?



There was vast ‘cross-provision’ of services between all the various NCRIS projects, demonstrating a high degree of interdependency. Below, this interdependency is shown for two selected NCRIS projects. Though even with just two examples, the message is clear: NCRIS projects are involved in a considerable level of cross-provision of resources.

To illustrate, Table 3 displays the services reported by Terrestrial Ecosystem Research Network (TERN) .

Table 3 Services reported by TERN

NCRIS Project	Service
Atlas of Living Australia	Data layers
AuScope Limited	Co-location of instrumentation
Australian National Data Service	Provision of data for ANDS client base
Australian Plant Phenomics Facility	Data layers and sharing of infrastructure
Australian Urban Research Infrastructure Network	Shared infrastructure and data
Bioplatforms Australia	Provision of genetic samples from field observation sites
Groundwater	Co-location of infrastructure
Integrated Marine Observing System	Data layers
National Computational Infrastructure	Act as test bed
NeCTAR	Provision of leadership for development of cloud computing and virtual laboratories
National Imaging Facility	Provision of samples from field observation sites
Research Data Services	Analytical tools

As a second example, the below table displays the the services reported by Bioplatforms Australia (BPA).

Table 4 Services reported by BPA

NCRIS Project	Service
Atlas of Living Australia	Environmental Framework Initiative collaboration
AuScope Limited	BASE framework
Australian Animal Health Laboratory	Genomics
Australian National Fabrication Facility	ARC Nanobio photonics
Australian National Data Service	Bioscience Research Data Cloud
Australian Phenomics Network	Genomics
Australian Plant Phenomics Facility	Genomics, metabolomics
European Molecular Biology Laboratory Australia	Bioinformatics, committee membership
Groundwater	BASE framework
Integrated Marine Observing System	Marine Microbes framework
National Computational Infrastructure	Genomics, bioinformatics
NeCTAR	Biosciences DEVL
Research Data Services	Biosciences DEVL, RDC, Antibiotic Resistant Sepsis Pathogens framework
Terrestrial Ecosystem Research Network	BASE framework
Translating Health Discovery	Genomics, proteomics, metabolomics, monoclonal antibody, stem cells, bioinformatics

As shown below, nearly 80% of NCRIS projects are used by researchers from the Biological Sciences, making it the field of research that makes use of the highest number NCRIS facilities. As expected, sciences, medical, and engineering fields are the primary users of NCRIS facilities, which largely reflects the results of the 2014-15 census. While the humanities are less likely to use any given NCRIS project, it is interesting that all fields of research, even fields such as Philosophy and Religious Studies, nevertheless make some use of some NCRIS facilities. These tend to be data or computing services, such as NeCTAR or Pawsey Supercomputing Centre (Pawsey).

Figure 6 Proportion of facilities providing services to various fields of research

As expected, the ‘professional, scientific and technical services’ industry catergory makes use of the highest number NCRIS facilities. Beyond this, the next most relevant industries for NCRIS facilities are the primary industries of Agriculture, Forestry, and Fishing, as well as Mining. Over half of all NCRIS facilities made use of these primary industries. Half of NCRIS facilities made use of the Manufacturing industry too.

Figure 7 Proportion of facilities providing services to various industries

3.3 Capacity and Utilisation

It can be seen in Table 5 that the proportion of projects having at least one oversubscribed technology platform has not risen since 2015-16. Nearly 80% of NCRIS projects have at least one technology platform at an utilisation level of 90% or greater, suggesting strong general utilisation. This figure also appears stable across the two years, suggesting capacity issues, while not getting markedly better, are importantly not deteriorating either. However, a strong theme emerging later in the Census was the need to build capacity to keep up with ongoing growth and change.

Projects with the highest proportion of hardware platforms oversubscribed include Translating Health Discovery (THD), Integrated Marine Observing System (IMOS), NCI, Heavy Ion Accelerators, and ANSTO NSF. In terms of absolute numbers of oversubscribed platforms, the Australian Microscopy and Microanalysis Research Facility (AMMRF) has the most oversubscribed hardware platforms.

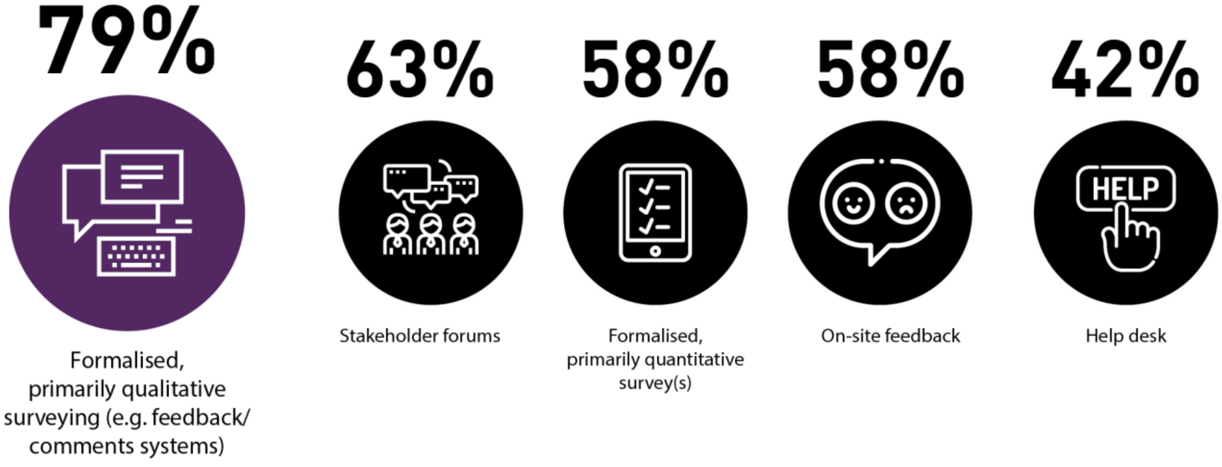
Table 5 Technology Platform utilisation

	2015-16	2016-17
Projects with any technology platforms >=90% used	19 79%	19 79%
Projects with any technology platforms oversubscribed	16 67%	15 63%

3.4 User Experience: Measuring Satisfaction

The popularity of the various methods of measuring user satisfaction can be seen below. Most NCRIS projects are using a selection of techniques for user satisfaction measurement, with 79% having some form of formalised system. Given the high existing use of user-feedback, this creates the opportunity to learn from projects who do this well, and roll-out a more standardised approach to collecting such information across the NCRIS program.

Figure 8 Methods of assessing user satisfaction



4.0 Impact of National Research Infrastructure

4.1 Academic Impact: Publications and Citations

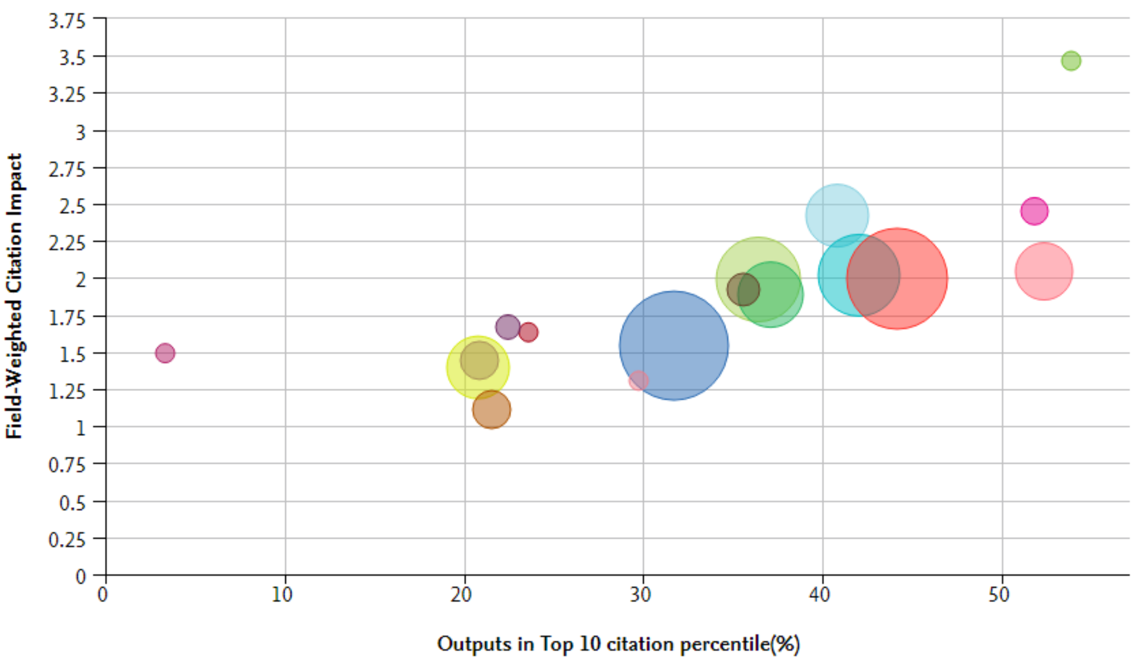
The census captured details from 22 of the projects on academic publications that had been created from research that made use of NCRIS infrastructure. The lists of publicatons were examined by the Department, through SciVal, and key findings are outlined in this section.

The analysis revealed some 5,660 publications from across the 22 projects. The publication dates were spread across the three calendar years of 2015 (1,748 publications), 2016 (2,075 publications) and 2017 (1,837 publications).

These figures appear to be lower than the publication numbers reported in the 2014-15 census of 4,549 in 2014 and 5,659 in 2015. There could be a number of reasons for the apparent discrepancy, but a key reason is likely to be the elimination of duplicate publications that is achieved by running the publications through a centralised analysis. It is easy to imagine double counting occuring under the previous method, especially given the high levels of collaboration between NCRIS projects.

The chart below shows the Field-Weighted Citation Impact of each[2] of the projects supplying publications data on the vertical axis, with the proportion of outputs in the top-10 citation percentile along the horizontal axis. The size of each bubble is proportional to the scholarly output (i.e. the number of publications) of each project. While the projects themsleves have been anonymised, the message is nonetheless positive. All projects reported Field-Weighted Citation Impacts above 1.0, as well has having at least approximately 20% or more of outputs rating in the top 10 citation percentile.

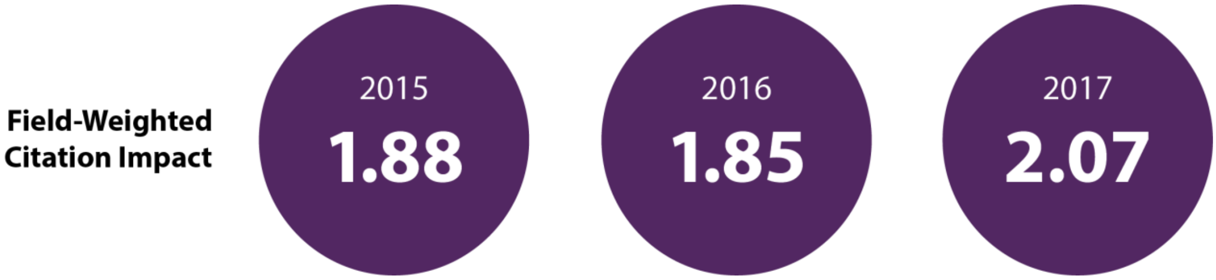
Figure 9 NCRIS Projects publication outputs: relative scores on Field-Weighted Citation Impact and top-10 citation percentile



[2] The chart does not include all NCRIS projects who completed the study. Some projects did not collect publications data, or otherwise provided only a partial list that was not necessarily representative of their entire list; hence they were not included in this chart.

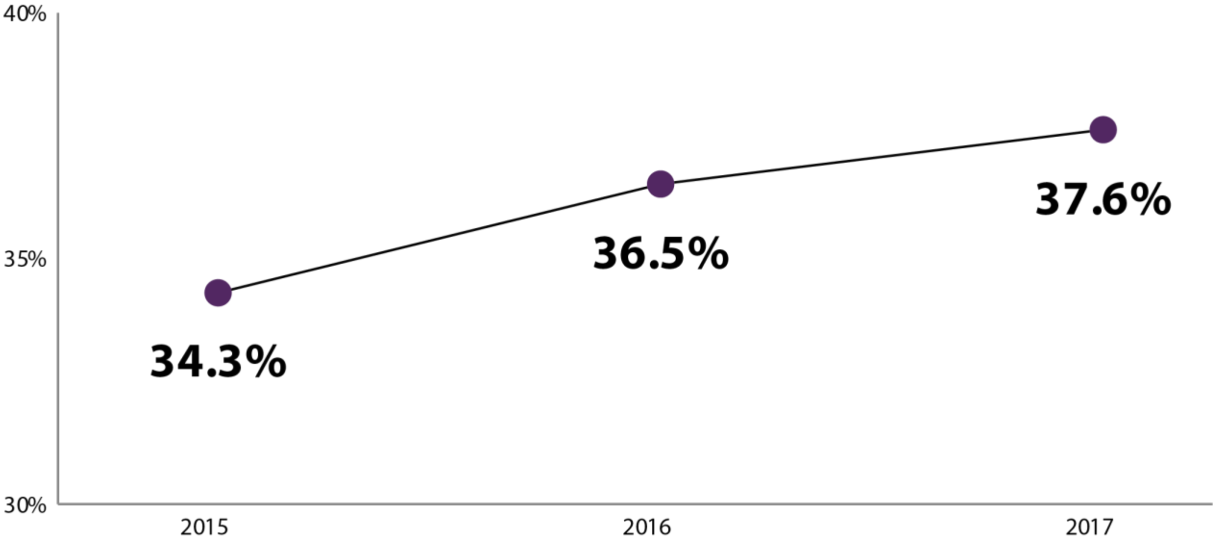
The Field-Weighted Citation Impact score for publications using NCRIS infrastructure has been well above 1.0 for the past few years. In 2017, the measure actually increased to 2.07, suggesting that the average publication emerging from NCRIS supported research has been cited more than twice as many times as would be expected for a similar publication in general.

Figure 10 Field-weighted citation impact, by year



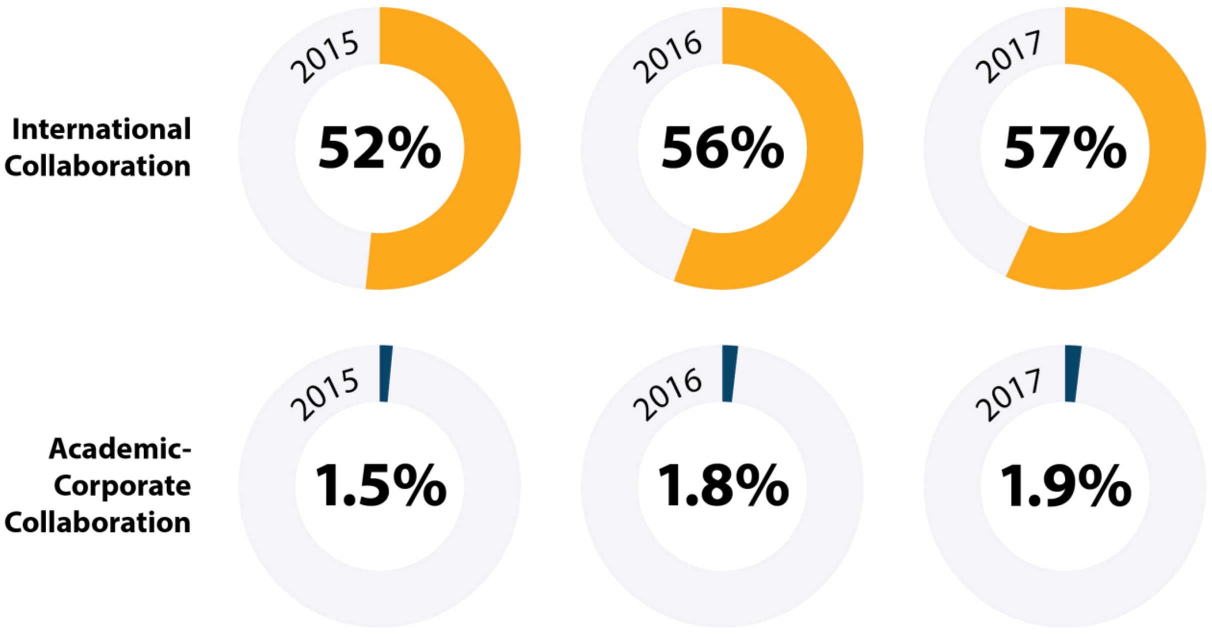
Publications created utilising NCRIS infrastrcture also tend to perform strongly in terms of citations. In 2017, almost four in ten of such publications (37.6%) performed in the top 10% of publications in terms of citations. This proportion has been increasing steadily since 2015, off an already impressive base.

Figure 11 Outputs in top citation percentiles (top 10%), by year



Exploring collaboration, the year-on-year figures provide pleasing results. The proportion of publications exhibiting international collaborations has risen from 52% in 2015 to 57% in 2017 (and as shown in section 5, many projects are wishing to expand their levels of international collaboration). While the proportion of academic-corporate collaborations evidenced is quite low, this figure, too, has been increasing year on year.

Figure 12 NCRIS-enabled publications: evidence of collaboration, by year



4.2 Promotional Activities

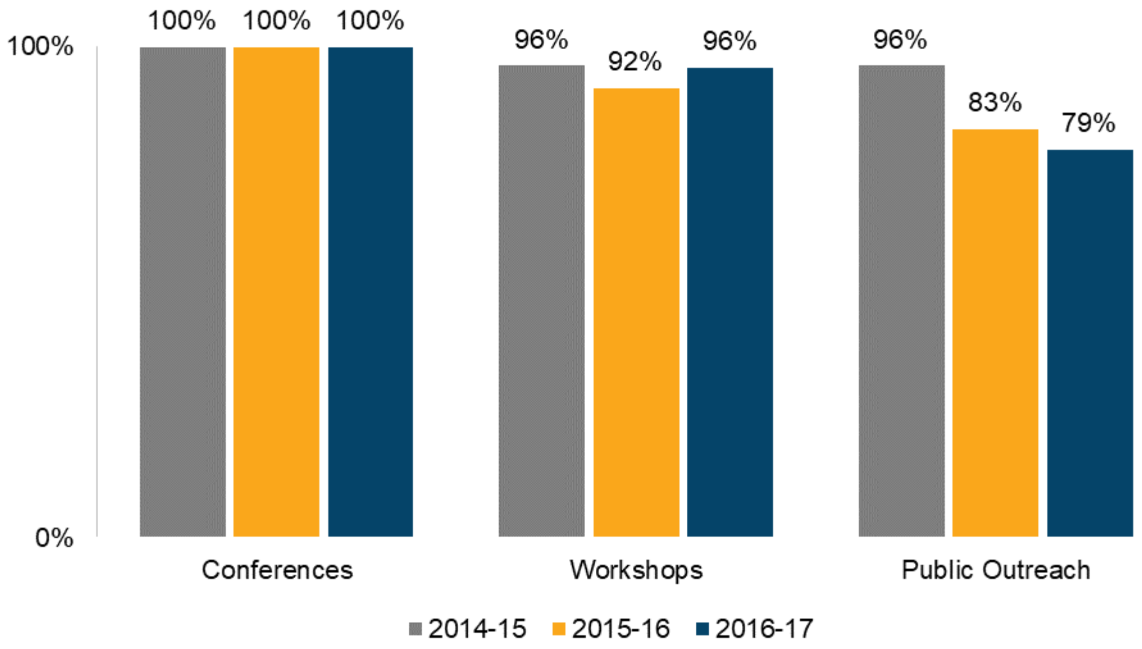
Twenty-one of the 24 projects responded that they had produced (or had published) some promotional articles or materials during the reference period. An examination of the census responses shows that newsletters are issued by many of the NCRIS projects, and that promotional materials sometimes include multi-media content (e.g. videos online).

Table 6 Proportion of Projects producing promotional articles / materials

	2015-16	2016-17
Yes	88%	88%
None / Not applicable	13%	13%

Although still highly popular as a promotional event, public outreach has become slightly less popular over the last three years. It would be interesting to understand whether this is a strategic decision by the projects that have moved away from public outreach, or whether it is in response to funding or resource constraints. Every NCRIS project has participated in conferences each year for the last three years.

Figure 13 Has the facility participated in any promotional events?



4.3 Enabling Government policies and programs

NCRIS projects are involved in a wide variety of policy areas. The raw data includes many examples, and the variety of initiatives underway makes them somewhat difficult to classify.

To illustrate, the example below shows the many ways that the Australian Urban Research Infrastructure Network (AURIN) enables government policy development and program delivery as well as supports government priorities.

Table 7 AURIN Roles in enabling government policy and program delivery

	Please outline the role of the project in providing critical or operational services/functionality to enable Government policies and program delivery...
(2015-16 and 2016-17 combined)	• AURIN assists all levels of government to deliver on their open data policies. • Tools to enable the integration of data related to human settlements • Federal, state and local government open data policies • State of the built-environment reporting • Monitoring the health and well-being of Australian citizens • Health planning access at the local, state and federal government • Monitoring Australia's progress towards the Sustainable Development Goals • Monitoring City Performance

Table 8 AURIN Support of Government Priorities

Please outline any key government priorities that are supported by the facility, and outline the nature of the support…	
2015-16	• Key indicators reported within the State of the Environment Report • Resilient Melbourne strategy • Identification of AURIN as a release authority for government. Productivity Commission, Public inquiry into Data Availability and Use • AURIN supports key transport strategies for Local Government (i.e. Darebin walking strategy)
2016-17	• Data Integration Partnership for Australia (DIPA) presentation at the inception meeting and assisting with setting the vision • AURIN has been identified as a partner for monitoring city performance within the Cities National Performance Framework final report • Department of Foreign Affairs and Trade, linking to AURIN to support the reporting of the Sustainable Development Goals (SDGs) • AURIN supports key transport strategies for Local Government (i.e. Hobsons Bay Integrated Transport Strategy 2017-2030), City of Melbourne - Melbourne for all people strategy (update). • The AURIN Economic Impact (Input-Output) Analysis Tool has been used by the South Australian Government for the allocation of resource royalties.

The following excerpts outline some of the ways vital Australian government services are dependent on NCRIS facilities.

Weather and climate modelling is critically dependent on NCI:

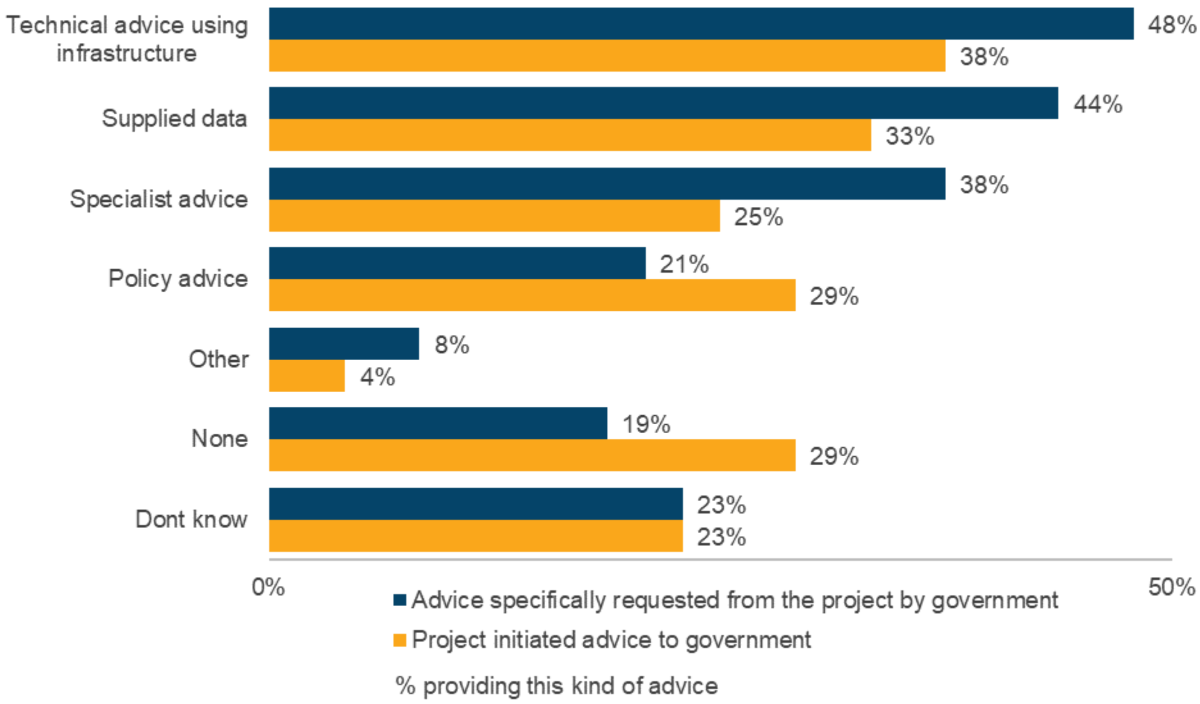
> *Performance optimisation of key elements of Australia's ACCESS weather/climate modelling suite for faster, improved weather forecasts, seasonal prediction and climate variability assessments*

Weather and climate modelling is also critically dependent on AuScope Limited (AuScope), as is resource exploration, amongst other vital capabilities.

> *Geospatial data products underpinning Government datum and mapping products supporting high precision spatial industries … To calculate atmospheric moisture underpinning climate and weather models … Critical to State Government resource exploration investment policy across most states and territories.*

More than half of NCRIS projects have been called upon by the government to supply some form of advice or data in order to inform government decision making. This demonstrates that government departments and agencies recognise the expertise of NCRIS personnel.

Figure 14 Types of advice provided by facilities



4.4 Commercial Impacts

Table 9 displays, at a total NCRIS program level, how many IP/commercialisation activities occurred during the reference periods as a result of infrastructure provided by the facility.

Although it appears that there is a lot of copyrighted material, it should be understood that 90% of the total in each year come from a single project, the AMMRF. With regard to clinical trials, nearly 90% of these are from THD.

Across most categories of commercialisation outputs, the trend is positive, with increasing outputs in 2016-17, relative to 2015-16. Categories that saw particularly strong growth included clinical trials and invention disclosures.

Table 9 Number of commercialisation Outputs, by year

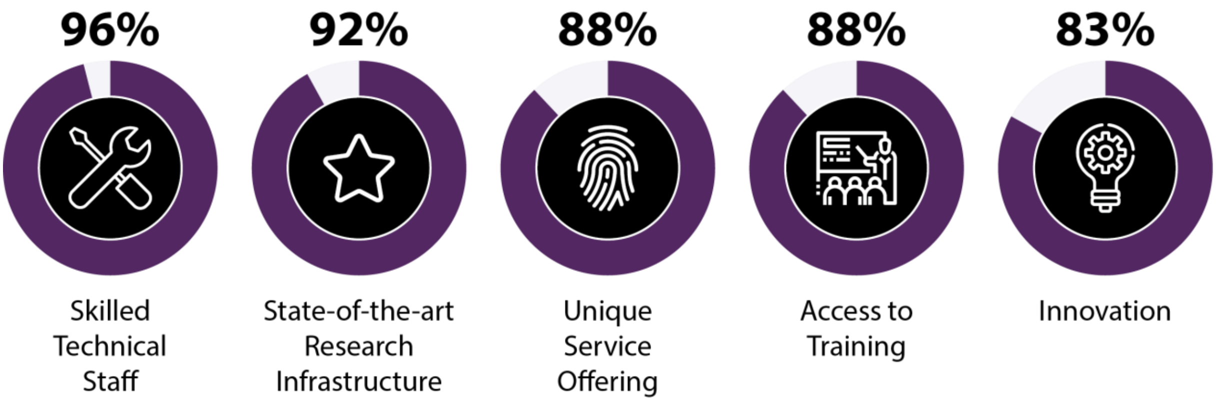
	2015-16	2016-17
Copyrighted Material	1108	1104
Clinical trials	157	265
Proof of concept	105	112
Invention Disclosures	65	111
Patents	40	46
Licences	44	34
Process improvements	14	13
Creative Commons-style licences	2	6
Products introduced to market	4	4
Plant Breeders' rights	8	4
New enterprises / spin-offs	4	3

Some of the other benefits mentioned by projects included Trademark filings, the issuing of open source software licenses, and licensing data for use.

4.5 Overall Impact: Key Advantages

Over 90% of NCRIS projects responded that concentration of skilled technical staff as well as greater access to state-of-the-art research infrastructure were key advantages that they offered their users.

Figure 15 What are the key advantages the project offers users?



The measurement of impact was extremely diverse across projects. Some projects stated that they had no formal measure of research impact in place. Some used simple metrics such as user/usage metrics. Some projects used publications. Many projects had a much more complex, qualitative, and/or elaborate approach to evaluating their impact.

For example, the AMMRF had this to say about its impact in 2016-17:

> *The AMMRF measures impact through a series of surrogate quantitative measures, as well as by case studies of research performed on our infrastructure. Our surrogate measures of impact include percentage of research publications in the top 10% of journals worldwide; how many patents include (or cite) work performed on our infrastructure, how many of our users come from outside the host facility; percentage of use by researchers from industry, amount of training of researchers.*

> *Highlights for the 2016-17 FY included:*
>
> - *AMMRF was awarded an Agility fund grant to upgrade our flagship instrument suite. In 2016 – 1540 publications*
> - *Incredible Inner Space, the AMMRF's touring exhibition of micrographs, went on show in the gallery at the Australian Embassy in Washington DC with an opening event held on 23 March. The Hon. Julie Bishop, MP also dropped in on the day of the launch and presented a promotional video for the exhibition*

5.0 Collaboration

Most projects have a variety of domestic collaborative arrangements. The high number of formal user consultative mechanisms stems from the AMMMRF, which makes up over half of the count for these in each of the reference periods. In terms of the high number of peer-review activities, the Australian National Fabrication Facility (ANFF) makes up a little under half of these in each of the reference periods.

Table 10 Program-Wide Domestic Collaborative Arrangements in Place, by Year

Domestic collaborative arrangements	Sum (2015-16)	Sum (2016-17)
Formal user consultative mechanism	1623	1865
Peer-review activities (publications etc.)	1714	1376
Invitations to speak at (domestic) international conferences, forums, meetings	462	513
Collaborations with other Australian non-NCRIS projects	339	464
Collaboration arrangements with NCRIS projects	108	118
Formal collaborative arrangements with international research infrastructure providers	91	106
Awards, commendations, used as exemplar	21	22
Other	226	226

The peer reviewing of publications is the most common international activity for NCRIS projects to engage in, and has also grown by nearly 60% since 2015-16. Amongst those projects with high counts in this area across both reference periods, TERN is the most prolific followed by Astronomy Australia Limited (AAL). However, the annual growth was almost entirely driven by NCI, which had a dramatic rise in the number of peer-review activities in 2016-17.

Invitations to speak at international conferences is the next most common international activity, and this was relatively stable across the reference periods. About a quarter of these are from BPA, but other than that, it is a very even spread of projects receiving conference invitations.

Table 11 Program-Wide International Activities in Place, by Year

International activities	Sum (2015-16)	Sum (2016-17)
Peer-review activities (publications etc.)	915	1446
Invitations to speak at international conferences, forums, meetings etc.	452	449
Visits from international bodies seeking advice	128	127
International research infrastructure facility management bodies that the project was involved with	89	106
Memoranda of Understanding (MoUs)	51	55
Awards, commendations, used as exemplar	31	38
Set-up selection processes and/or reviews of international research infrastructure	21	20
Other	72	109

As seen in the figure below, the vast majority of projects are involved with global research infrastructure.

As an example, the National Imaging Facility (NIF) stated that:

> *National Imaging Facility has a Memorandum of Understanding (MoU) with the EuroBioImaging that recognizes the desire of both research infrastructures to enter a mutually beneficial alliance in supporting the advancement of scientific research. NIF is also a partner in Global BioImaging Project, funded by the European Commission's Horizon 2020 Programme. UoM node of NIF is a participant in ADMI (Alzheimer's Disease), TrackHD (Huntington's Disease), Siemens 7T MRI Development, PET/CT Siemens scanner Development, and Monash node of NIF at MBI collaborates with Julich Forschungzentrum, a member of the Helmholtz Association of German Research Centres, which is one of the largest interdisciplinary research centres in Europe. Finally, UWA node of NIF is a partner in Nikon CoE.*

Additionally, some two thirds of NCRIS projects plan to **increase** their involvement in global research and/or international collaboration in the future.

Figure 16 Partnership in global research infrastructure, and plans for the future

Projects tend to find that global or international participations often leads to further global or international opportunities.

For example, the Australian Plant Phenomics Facility (APPF) stated that:

> *New plant phenotyping networks and centres are being established in China, India and other Asian nations, which provide a great opportunity to extend our international collaborations and for further commercialisation of APPF developed infrastructure (e.g. Phenomobile).*

Some of the most frequent reasons for why projects would like further global engagement are expressed concisely by the Australian Phenomics Network (APN):

> *To provide access to international best practice policies and procedures [as well as] to contribute and access international datasets and other resources.*

6.0 User Charges and Funding

6.1 Users and user charges

It can be seen in Table 12[3] that, with the exception of one NCRIS facility which charges government users full cost, it is only industry users who are charged full cost for accessing NCRIS facilities. Even so, it is still just under half of applicable NCRIS facilities that charge industry users full cost. Academic researchers are typically charged either the marginal cost or no cost at all.

For some NCRIS projects, user interactions are such that a charging policy is not applicable. These projects have not been included in the formulation of the below table.

Table 12 Charging Structure, by User Types

User	No costs (based on merit selection)	No costs (based on open access)	Marginal Cost	Full Cost	Other arrangement
Meritorious researcher	24%	33%	24%	0%	19%
Early-career researcher	19%	29%	33%	0%	19%
Other academic researchers	10%	30%	45%	0%	15%
Industry	0%	11%	16%	47%	26%
Government	6%	29%	29%	6%	29%
Other user type	0%	33%	17%	0%	50%

The total NCRIS revenue, from user-charging rose by 24% from the 2015-16 to 2016-17. However, in the same time, the median fell by 32%. Also, the median is much lower than the mean. This indicates that the distribution of project revenue is positively skewed, and that the growth has occurred primarily amongst the higher revenue earners. Both figures are also higher than the $64.7m reported in the 2014-15 census. This can be seen in the below table.

Table 13 Program Wide User Charges Revenue[4]

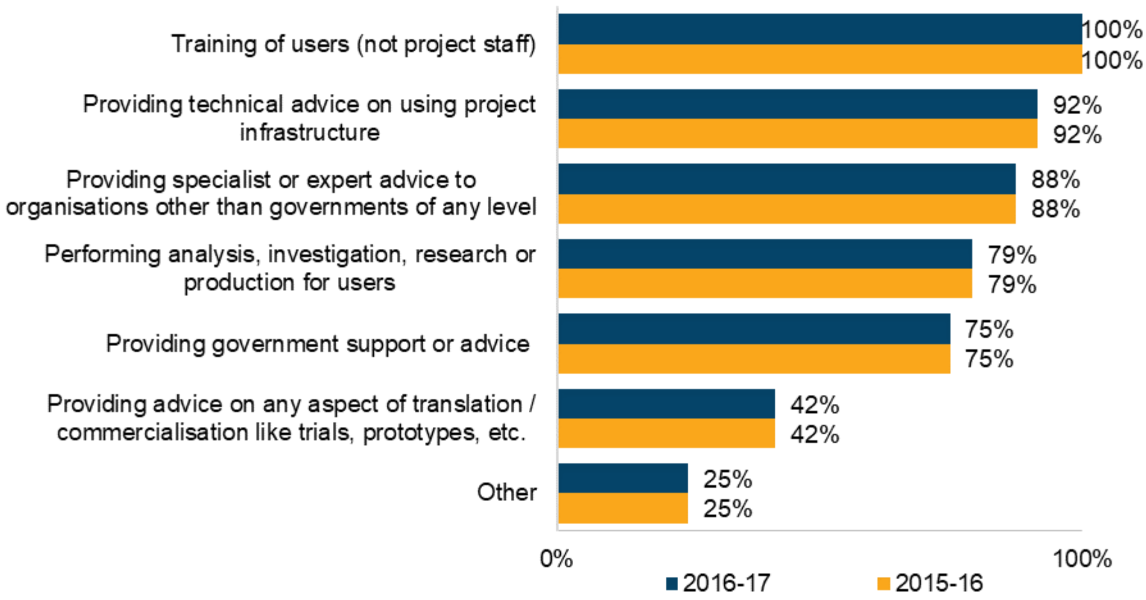
Project revenue from User Charges	2014-15 FY	2015-16 FY	2016-17 FY	% Change year-on-year
Sum	$64,706,513	$84,575,346	$104,609,455	24%
Mean	$3,806,265	$4,975,020	$6,153,497	24%
Median	$582,000	$1,234,606	$841,940	-32%

[3] Table has been re-percentaged to exclude ‘not-applicable’ responses.
[4] This table includes only the 17 NCRIS projects who reported receiving user-charging revenue. The table also incorporates figures from the 2014-15 census.

Table 13 includes only the revenue from the 17 NCRIS projects who reported receiving user-charging revenue during the 2015-17 period captured in the census.

All NCRIS projects provided user training to researchers, and 22 of the 24 projects provided technical advice on using their infrastructure. The chart below indicates NCRIS projects that are very strong in terms of training and assisting researchers to make the most out of their infrastructure. Support is not only offered at the initial data collection phase, as 19 NCRIS projects also provided 'value added' services such as performing analysis, investigation, research, or production for users. Some projects offered support even further along the research production chain. An example of such support comes from AURIN who has also provided users with advice on preparing data for publication.

Figure 17   Types of user service or support offered?



6.2   Co-investment

While Co-investment is not a condition of NCRIS program funding, the Commonwealth Government encourages collaboration and co-investment among universities, state and territory governments, PFRAs, independent and private sector research organisations, industry and philanthropy. Co-investment includes cash contribution, as well as in-kind contributions. In-kind co-investment typically takes the form of, but not limited to: staffing on cost, rent/space, legal support, HR support, or a portion share of capital and operating expenses to leverage on the partnership.

- Co-investment data is based on financial information provided by NCRIS facilities as part of developing the Research Infrastructure Investment Plan as well as the NRI Census.

The number of NCRIS projects that receive financial co-investment has increased since 2015-16, as shown in Table 14. Those receiving in-kind co-investment remained high, and steady at the rate of 79% of projects.

Table 14 Proportion of NCRIS Projects receiving cash and in-kind co-investment

	2015-16	2016-17
Financial co-investment excluding funding and grants	67%	79%
In-kind co-investment	79%	79%
None of the above	21%	17%

The sum of cash contributions has more than doubled since 2015-16, as shown below. However, it can be seen that the mean is much higher than the median and that the growth of the median contribution, while substantial is much less than the growth of the mean. This indicates that the distribution of contributions is positively skewed. The growth in cash contributions is primarily happening amongst those organisations that are already amongst the higher recipients of cash contributions.

There has not been any growth for in-kind contributions, and instead there has been roughly a 5% contraction, although it is possible this is because some in-kind contributions have become cash contributions.

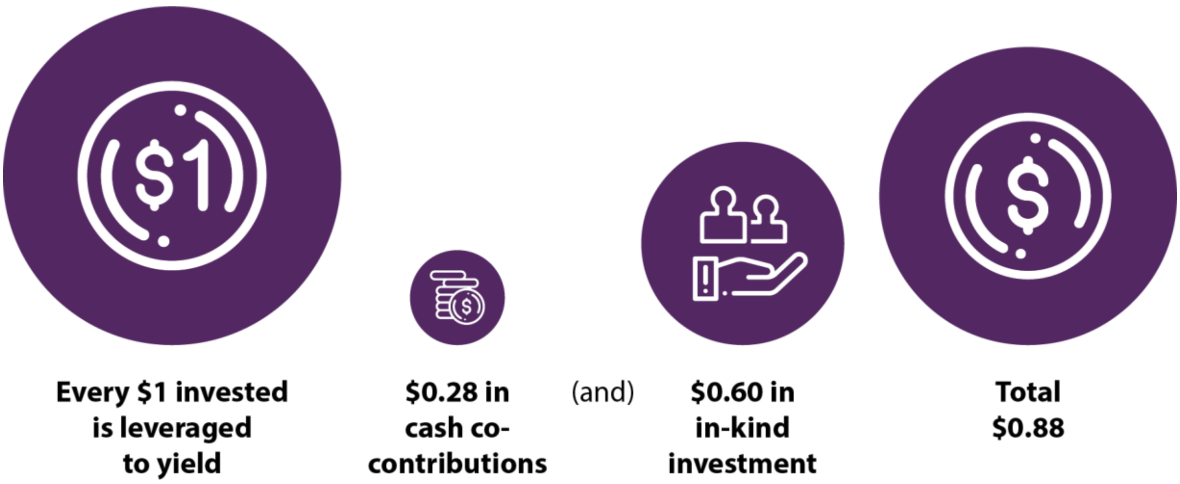
Summing all cash and in-kind contributions together, there has been 14% growth since 2015-16.

Table 15 Program-wide Cash and In-kind contributions

Co-investment	2015-16		2016-17	
	Cash	In-kind	Cash	In-kind
Sum	$54,973,386	$250,705,450	$111,110,878	$237,857,298
Mean	$2,290,558	$10,446,060	$4,629,620	$9,910,721
Median	$1,016,346	$1,400,000	$1,313,045	$2,462,366

Combining the co-investment figures for 2016-17 with NCRIS funding figures provided by the Department, yields the funding 'multipliers' shown below. At the program level, we see that NCRIS projects are able to leverage some 28c in cash co-contributions, and 60c in 'in-kind' contributions for every $1 in core funding invested. This yields a total multiplier of 88c in the dollar, or very roughly approaching a one-to-one ratio.

Figure 18 Funding Multipliers



In addition to the co-investment information provided in the census, the above multiplier calculations are based on financial information provided by NCRIS facilities as part of the development of the Research Infrastructure Investment Plan.

7.0 People

7.1 Headcounts and Representation

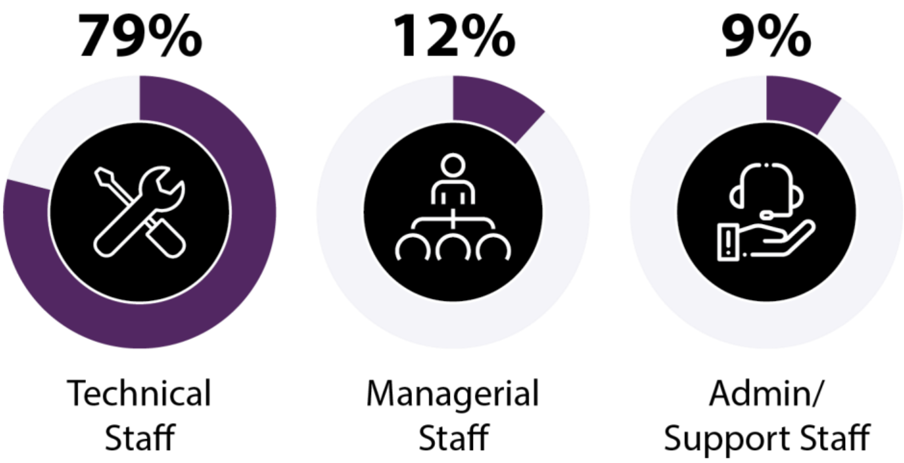
The program-wide headcount was broadly stable from 2015-16 to 2016-17, at just under 2,000 positions. There was a modest 3% growth in the number of full-time equivalents (FTE) during the same period. These results are broadly similar to 2014-15, when the total headcount was listed as 2,023 (across 26 Projects).

Table 16 NCRIS Program-wide staffing

Total NCRIS	2015-16	2016-17	Change
Headcount	1,963	1,975	1%
Full-time equivalent positions	1,529	1,573	3%

The vast majority (79%) of staff employed at NCRIS facilities are employed as technical staff, with managerial staff making up 12%, and only nine per cent of headcount being administrative.

Figure 19 Staff categories, as a proportion of headcount



Across all the NCRIS projects, only one in four staff members are female, and this has remained steady since 2015-16. Therefore, this stands out as an area for improvement with regard to proportion of females employed by NCRIS projects. The project with the highest rate of female employment is the APN, of which 73% of staff are female. With regard to female leadership, five of the projects have a female employed as their most senior executive. These include the APPF, the Population Health Research Network, the ANFF, the AMMRF, and TERN.

Table 17 Proportion of NCRIS staff that are female[5]

Total NCRIS	2015-16	2016-17
Proportion of staff that are Female	25%	26%

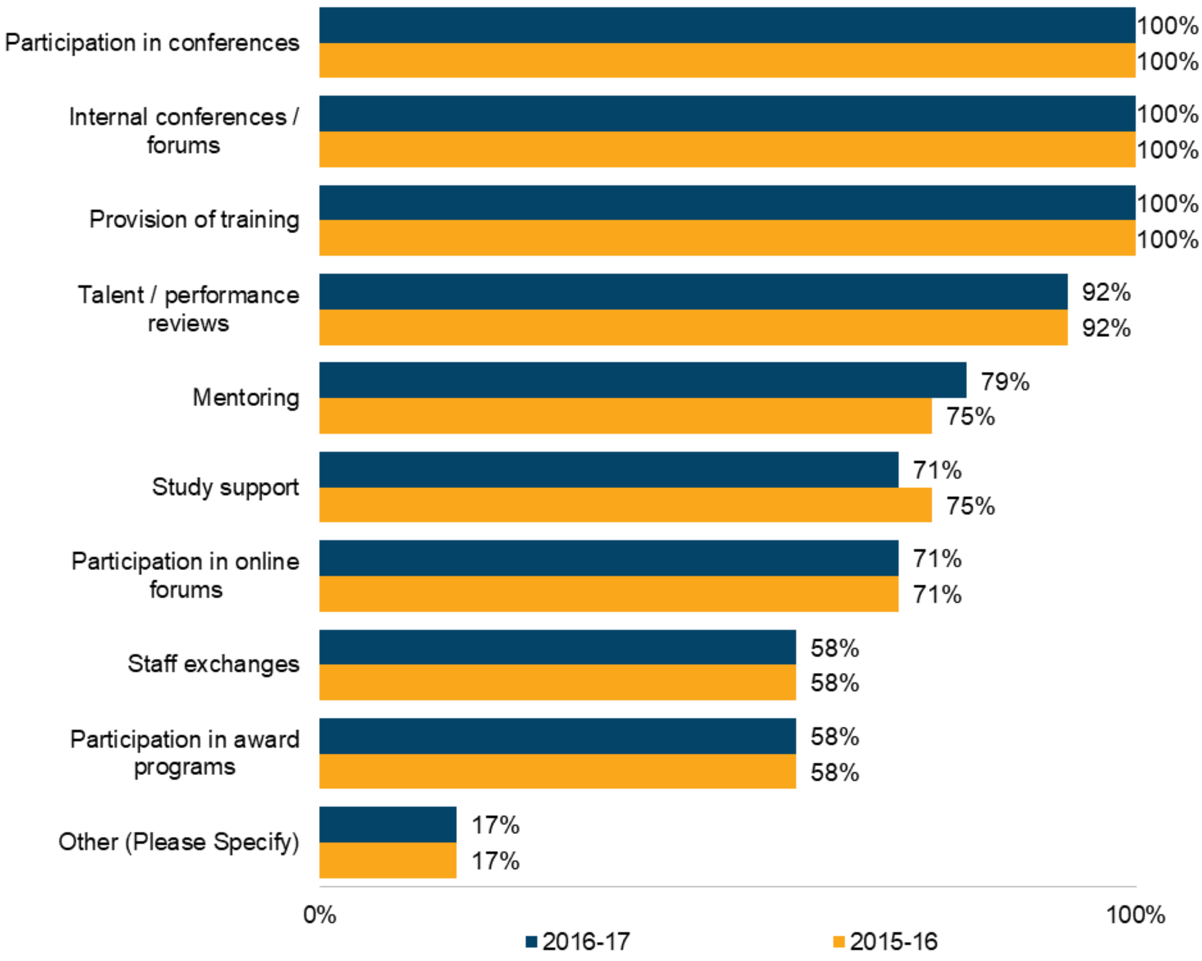
[5] Note that only 19 of the 24 NCRIS projects were able to provide a gender breakdown of their staff. The other five projects were unsure of their gender breakdown.

7.2 Building Human Capacity

All NCRIS projects used participation in conferences as well as provision of training to create career progression opportunities. Every single activity on the list is offered by the majority of NCRIS projects. This indicates that NCRIS projects place a high degree of importance on training and professional development.

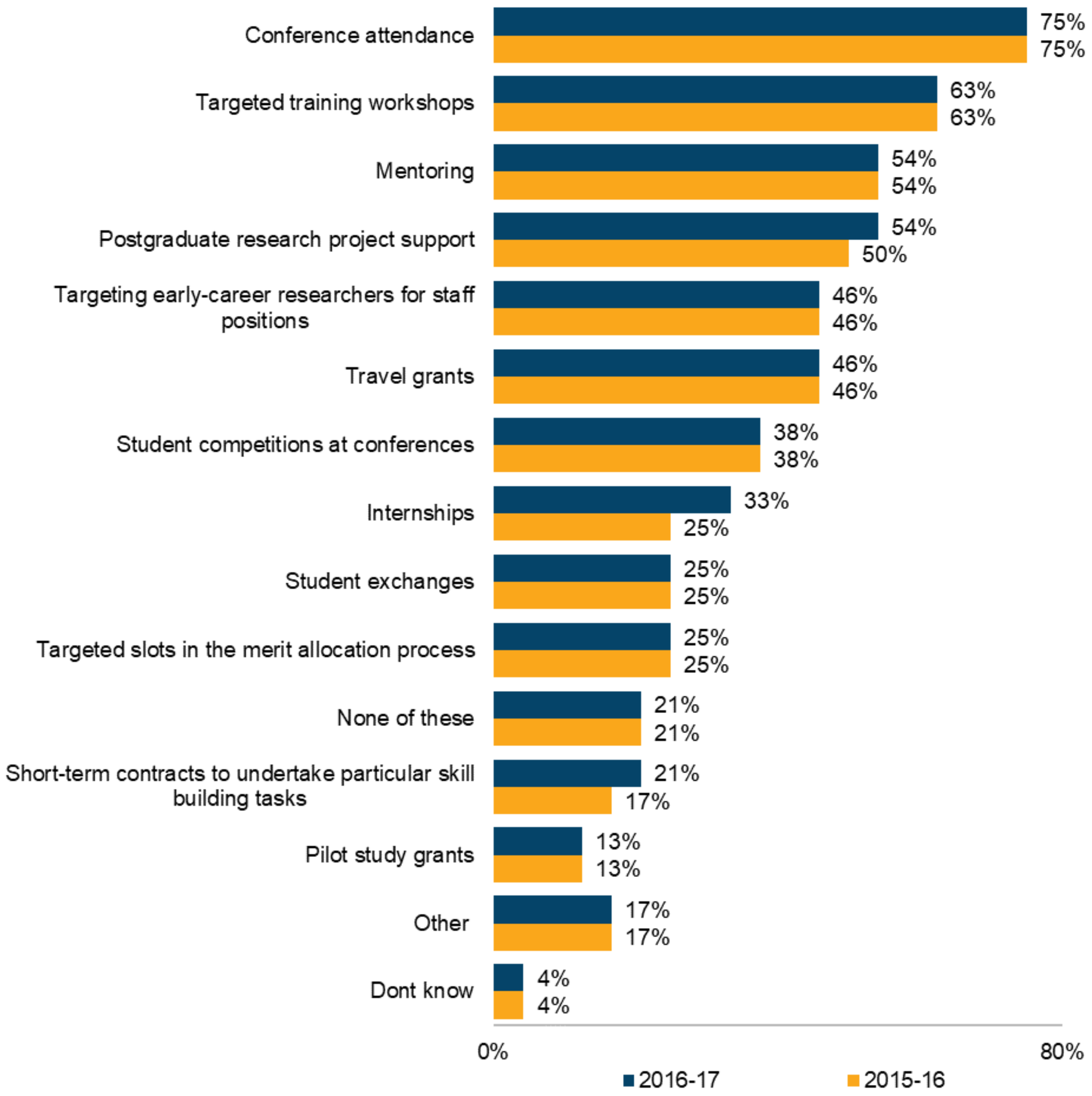
One of the more exciting activities mentioned was from the AMMRF, which has a program where employees shadow staff in an overseas facility.

Figure 20 Activities conducted to build technical skills or create career progression



Conference attendance is also the most frequently employed early-career initative. More than half of the NCRIS projects also use initatives more specific to early-career researchers, such as targeted training workshops as well as mentoring. However, less than half of NCRIS projects target early-career researchers for staff positions. While only a quarter of NCRIS projects offered internships in 2015-16, in 2016-17 a third of NCRIS projects were offering internships.

Figure 21 Early-career researcher initiatives offered by projects



8.0 NRI Technology Platforms: Costs, Financial risk and future challenges

8.1 Costs and life-stage

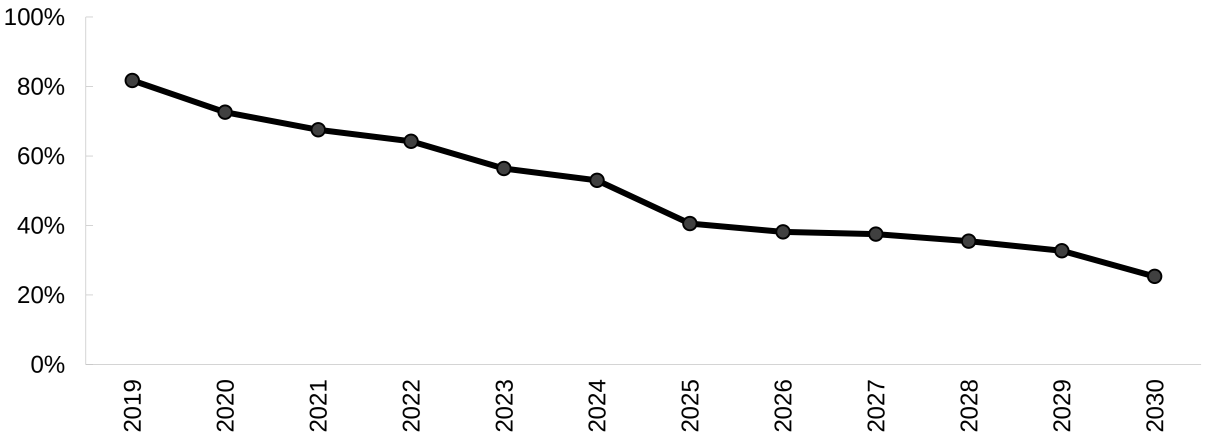
With regard to operational costs, the mean is over 5 times the median. This indicates that the mean operational cost is being dragged higher by a small number of projects with very high operational costs.

Table 18 Program-wide Establishment and Replacement Costs

	Sum	Mean	Median
Establishment costs	$ 1,949,704,287	$ 81,237,679	$ 67,467,908
Replacement costs	$ 1,941,236,660	$ 80,884,861	$ 52,927,000
Operational costs	$ 1,172,061,124	$ 48,835,880	$ 8,668,551

The below chart displays the estimated percentage of technology platforms that will have reached their predicted end-of-life at a given date. It can be seen that 50% of technology platforms in existence in 2017 are estimated to have reached their end-of-life date by 2025. It should also be noted that 14% of technology platforms were considered to essentially have an indefinite lifespan, subject to funding.

Figure 22 Estimated percentage of 2017 technology platforms to have reached their predicted end-of-life



Half of the NCRIS projects have at least one technology platform with risk of obsolescence in the next four years. A similar proportion of NCRIS projects have at least one technology platform with the risk of some sort of failure during the same period.

Figure 23 Risks of technology platform failure and obsolescence

47%
Projects with any tech platform with some risk of failure

50%
Projects with any tech platform with some risk of obsolescence

Comments about the end-of-life scenarios and risk of failure are as varied as the technology platforms themselves. The following is an example of a comment submitted by IMOS, which highlights the need for projects to have fiscal injections that allow for more than basic operation and maintenance, but rather investment in new technology.[6]

> *Without additional funding in the next four calendar years … deferred capital replacement and required technology refreshment will further erode our ability to respond to the Roadmap. We estimate that it would require another ~10% reduction of scope in 2019-21 to manage these issues on a flat budget. The Baseline Scenario therefore commits us to gradual reduction in scope over time, and the question will be at what point we no longer have a truly national scale, integrated, marine observing system.*

The following is an excerpt of a comment about a technology platform with a significant risk of failure, coming from NCI about its National Peak High Performance Computing (HPC) System. It highlights the vital need to regularly plan ahead with regard to technology and infrastructure investment.[7]

> *There is significant risk of failure of the current supercomputer (now beyond its end-of-life) before it is replaced in 2019. There will be a major or even a complete loss of the service provided by Australia's most powerful R&D supercomputer should it fail prior to the commissioning of the new system. This will impact the university sector, PFRAs, MRIs, industry, and NCRIS research infrastructure …. Regular investment in advanced technology is required to map future major infrastructure developments. Future major system upgrades cannot be planned accurately in the absence of an advanced technology testbed*

The above comment was typical for computing based technology platforms found across various NCRIS projects, including (but not limited to) NeCTAR, Pawsey and RDS.

8.2 Infrastructure Challenges for the future

Some infrastructure challenges include the need to meet international standards, as well as the importance of funding not only for establishment, but maintenance / ongoing costs. This can be particularly important in an era where ongoing quality accreditations are essential.

[6] The substance of this comment has been addressed in the Research Infrastructure Investment Plan
[7] The substance of this comment has been addressed in the Research Infrastructure Investment Plan

As an example, below is a response from THD:

> *INCREASING QUALITY DEMANDS ON EQUIPMENT AND SERVICES:*
> *The capital equipment component of the current THD consortium is in serious need of refreshing, replacement and upgrade. Putting aside the operational, capacity and efficiency reasons for this need, it is likely that more and more facility users will require laboratories to be ISO-accredited (or similar) in order that a user can have confidence that the results can be used in regulatory submissions. Quality systems and their accreditation require a great deal of investment in terms of equipment maintenance, certification and staff training, as well as requiring dedicated FTE to act as facility quality managers. Thus it is imperative that future infrastructure investment goes beyond purchase and installation and includes resource for not only ongoing maintenance, but the establishment and maintenance of quality systems and accreditation.*

Similarly, from the NIF:

> *Maintaining the competitiveness status of the capability. Due to lack of Capital funding and Operational funding (for equipment maintenance), NIF technologies are no longer cutting-edge with many in urgent need of either upgrade or replacement. This leads to a decline in Facility usage and performance over time. Both Capital and Operational funding are required for development of a replacement plan for obsolete and an upgrade plan for non-obsolete technologies.*

Some infrastructure challenges from NCRIS projects were concerned with the need to keep on top of new and/or rapidly developing technologies that are providing enormous opportunities in their sector. As an example, below is a response from AuScope about the opportunities set to be offered by UAV technology.

> *The rapid development of new UAV and drone technologies will provide opportunities that have never before existed for the collection of geophysical and remote sensing data across Australia and Antarctica. Advances in swarm flight control software, miniaturisation of sensors and new sampling techniques provide very exciting opportunities. However regulations relating to UAV operation (CASA), data delivery and analysis workflows and cost of access to high quality UAVs and trained pilots create a barrier to entry for many research programs. AuScope hopes to address these challenges over the coming years.*

Another theme is the vital need for computational infrastructure. These concerns are not only expressed by the many NCRIS projects whose facilities revolve around providing this computational infrastructure, but also those facilities who rely on the services provided by computational infrastructure facilities. For example, see this response from AAL:

> *Computing and data research infrastructure as with many disciplines, computing and data research infrastructure is growing in importance to astronomy, and is becoming the critical bottleneck to the success of many new telescope projects. This is particularly true for radio telescopes; however, the scientific discoveries enabled by combining data-products from multiple telescopes operating at different wavelengths also requires appropriate computing and data research infrastructure for optical telescopes. Given the cost of modern high performance computing (HPC), Australia has taken a cross-disciplinary approach to funding and operating HPC, that is, NCI and the Pawsey centre are each funded to support a variety of scientific disciplines. While such a cross-disciplinary approach has advantages, it is critical that those HPC centres have the systems, processes, and technical capacity to understand and meet the needs of Australian-based astronomers.*