PART 2
PERFORMANCE

CHAPTER 3: OUTCOME
A report on the ARC’s effectiveness in achieving its outcome

CHAPTER 4: PROGRAM 1.1 DISCOVERY
A report on achievements during the year in relation to Discovery deliverables and key performance indicators

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A report on achievements during the year in relation to Linkage deliverables and key performance indicators

CHAPTER 6: PROGRAM 1.3 EXCELLENCE IN RESEARCH FOR AUSTRALIA
A report on achievements during the year in relation to ERA deliverables and key performance indicators
Future Fellow, Professor Sharynne McLeod, Charles Sturt University, is looking at international speech acquisition by Australian children. Photo courtesy of Charles Sturt University.
Under the Australian Government’s Portfolio Budget Statements 2013–14, Budget Related Paper No. 1.12, Industry, Innovation, Climate Change, Science, Research and Tertiary Education Portfolio, the Outcome statement for the ARC is:

‘Growth of knowledge and innovation through managing research funding schemes, measuring research excellence and providing advice’.

The case studies in this chapter are examples of new knowledge and innovation arising during 2013–14 from the three activities identified in the Outcome.

‘Growth of knowledge and innovation through managing research funding schemes...’

The National Competitive Grants Program (NCGP) case studies provide evidence demonstrating the economic, environmental, social, health and cultural benefits to Australia arising from ARC-funded research. The range of case studies demonstrates the diversity of ARC-supported research conducted by individual and teams around Australia.

Unless otherwise indicated, the case studies relate to research projects awarded funding under the NCGP in previous years that have achieved outcomes in 2013–14. The case studies provide examples of the benefits of research generated in the short term (that is, during the course of the research project). The full impact of the ARC’s investment in research and training can be assessed comprehensively only over the longer term.

‘Growth of knowledge and innovation through...measuring research excellence...’

The Excellence in Research for Australia (ERA) case studies provide evidence of the benefits to Australia arising from the ARC’s evaluation of research quality in Australian universities.

‘Growth of knowledge and innovation...by providing advice’

The policy case studies describe areas of ARC policy analysis during 2013–14 aimed at ensuring the NCGP continues to contribute to building research capacity in Australia.
CASE STUDY

ARC FELLOWS RECOGNISED AS AUSTRALIA’S RESEARCH LEADERS

In 2013–14 ARC-funded researchers continued to be recognised for their research achievements and contributions to increasing Australia’s research capacity.

Professor Rob Brooks, The University of New South Wales

Professor Rob Brooks is an evolutionary biologist who, in his own words, ‘thinks about sex for a living’. An ARC Professorial Fellow, Professor Brooks is Director of the Evolution and Ecology Research Centre at UNSW Australia (The University of New South Wales).

Professor Brooks’ ability for engaging the public in the science of evolutionary biology was recognised through the awarding of the 2013 Australian Government Eureka Prize for Promoting Understanding of Australian Science Research. This was following a prolific publication output which includes an award-winning book Sex, Genes & Rock ‘n’ Roll: How Evolution has Shaped the Modern World (2011), and dozens of articles for The Conversation, as well as regularly appearing on national television and radio.

Through his writing and community engagement, Professor Brooks sets the challenge to rethink how our society works by looking at it through an evolutionary prism. He asks people to consider how the consequences of sexual reproduction could relate to the role of religion, to attitudes about gender equality, and questions of morality. By initiating discussion and reflection on these topics, Professor Brooks encourages individuals to undertake their own curiosity-driven research. Professor Brooks’ research group also conducts ARC-funded evolutionary research on guppies, field crickets and mice.
Professor Frank Caruso is an ARC Australian Laureate Fellow who specialises in developing advanced materials for biotechnology and medicine. His talents are in bringing together diverse teams of researchers to combine expertise in chemistry, biology, medicine and engineering.

Professor Caruso’s work has recently been recognised by the award of the prestigious 2013 Commonwealth Scientific and Industrial Research Organisation (CSIRO) Eureka Prize for Leadership in Science. At the award event, Frank Howarth, Director of the Australian Museum, praised his work, noting that ‘Frank Caruso has succeeded in creating a new field of science creating interdisciplinary approaches to push forward the boundaries of nano-medicine, nano-biotechnology and drug delivery’.

During his tenure at The University of Melbourne’s Department of Chemical and Biomolecular Engineering, Professor Caruso has gained a global reputation as a researcher and author of over 340 peer-reviewed papers. In 2011 he was ranked at number 17 on a list of the world’s top material scientists, based on a citation impact analysis conducted by Thomson Reuters, and was named a Highly Cited Researcher in 2014 by Thomson Reuters.

Professor Caruso’s work in engineering nanoparticles for drug delivery has achieved international media attention. Using advanced techniques to engineer microscopic capsules made out of natural ingredients, drugs can be precisely delivered where they are needed, and can be programmed to release their contents at a given time, all of which promises to reduce the size of the dosage required.

‘These nano-engineered capsules are attracting much attention as drug carriers, as they have the potential to improve the delivery and effectiveness of drugs while reducing their side effects,’ Professor Caruso said.

Photo: Professor Frank Caruso (R) with Dr Yan Yan (C) and Dr Markus Muelner (L).
EUCALYPTUS FOREST WATER MANAGEMENT

Dr Melanie Zeppel, Macquarie University
Schemes: Discovery Early Career Researcher Award, Discovery Projects

A Macquarie University researcher has made some remarkable findings about the way Eucalypts use water and the impact of extreme rainfall on plant growth. Dr Melanie Zeppel’s analysis of 21 Eucalypt species found that all Eucalypts measured across Australia use the same amount of water for a certain quantity of leaf material regardless of tree size. Combining this result with satellite imaging to gauge plant cover, she has been able to calculate the amount of water used by Australian Eucalyptus forests on a large scale. This result provides important data to balance forest water needs with other critical requirements.

Dr Zeppel has also been investigating how plants will respond to seasonal changes to precipitation, including more extreme rainfall. Fewer but more intense heavy rain events and changes in the timing of seasonal rain will change the soil water content. The study found this has consequences including delayed flowering, considerably reduced fruit production and smaller plant size depending on the current conditions in the region and the timing of rainfall shifts.

The results of Dr Zeppel’s research significantly improve both our understanding of the amount of water eucalyptus forests use—from single forest up to the continental scale—as well as the responses of plant and ecosystems to extreme rainfall and seasonal rainfall variations. These findings will provide invaluable assistance to a range of stakeholders engaged in the management of Australia’s water and vegetation resources in future changing climatic conditions.

Photo: Dr Melanie Zeppel. Courtesy of Ariel Mack.
Although there is considerable research into the nutritional value and composition of milk, little is known about the way in which milk—and specifically milk fats—are digested by the body. This includes understanding how babies digest breast milk, through to how adults process cow, goat and other milk products.

In 2013–14 researchers from Monash University made new discoveries that have furthered our knowledge of milk digestion and may lead to a range of novel applications. With funding from the Discovery Projects scheme and utilising specialist instruments at the Australian Synchrotron, Professor Benjamin Boyd and his team have documented the nanostructure of milk, and how its fats interact with the human digestive system.

By chemically recreating the human digestion of cow’s milk in laboratory conditions and using this material in the beamline at the Australian Synchrotron, the researchers were able to examine the simulated digestion in minute detail and accelerate their research. The team discovered that, at the nanoscale, milk has a highly geometrically ordered structure when being digested. This organised structure assists the delivery of milk components to a cell through the cell membrane.

By unlocking the detailed structure of milk, the research provides a framework for the development of new milk products, including: milks for premature babies and dairy products for people with intolerances; as well as milks with an increased nutritional value. It could even harness milk’s ability to act as a ‘carrier’ to develop new forms of drug delivery.

Photo: (L to R) Professor Ben Boyd, Ms Stephanie Phan, Dr Stefan Salentinig, Mr Jamal Khan.
In the past, explosives identification has focused on detecting the metals encasing the explosive substances. However, improvised explosive devices are now more common and often contain no metal. There is, therefore, an urgent need to be able to detect the explosive material itself.

In 2013–14 a team of researchers from The University of Adelaide created a sensor that can detect tiny quantities of explosives with the use of light and special glass fibres. The technique uses a plastic material which emits red light when illuminated with green laser light. The amount of red light emitted is reduced by the presence of explosives providing an accurate indicator.

The project leader, Dr Georgios Tsiminis, was attracted to Australia to undertake this research and is funded through the Super Science Fellowships scheme. He has discovered that this technique is highly sensitive, is able to detect trace quantities of explosive and only takes a few minutes. Swabs can be taken from a variety of surfaces and produce a result that confirms the presence of explosives, in concentrations as low as 6.3 parts per million, in real time. These attributes—combined with the fact that it is inexpensive, quick and easy to use—could make it of significant benefit to forensics investigators worldwide.

Photo: Dr Georgios Tsiminis.
REVOLUTIONISING HEALTH CARE DIAGNOSTICS

Associate Professor Dayong Jin, Macquarie University
Schemes: Discovery Projects, Future Fellowships

Researchers from Macquarie University have invented a new generation of nanocrystals called T-dots which have the potential to revolutionise health care diagnostics. The researchers have discovered a technique to control the length of time that light is emitted from fluorescent nanocrystals, which can be used to track pathogens or drugs in the body.

The addition of a time dimension in measuring nanocrystals significantly increases the number of combinations of T-dot codes that could be used as unique signatures for biomedical screening and diagnostics, creating vast libraries of nanotags. Tests using T-Dots would be able to quickly and precisely identify disease agents or detect cancers. T-Dots could also be used to manufacture unforgeable invisible marks on currency or pharmaceuticals as anti-counterfeit measures, and by layering T-Dots, improve data storage capacity.

This breakthrough received Discovery Projects scheme funding and was co-led by Associate Professor Dayong Jin, an ARC Future Fellowship recipient and a chief investigator of the recently funded ARC Centre of Excellence for Nanoscale BioPhotonics, who designed and manufactured the nanoparticles. Continuing their international partnership with colleagues from the United States and China, the research team have recently successfully detected trace amounts of multiple viruses’ DNAs within minutes using a single test. They were able to correctly read and recognise nanotags attached to DNA strands of HIV, Ebola and other viruses at high speeds. This technique is one of many applications that could save vital time in identifying diseases, enabling earlier and more cost effective medical interventions.

Photo: Associate Professor Dayong Jin.
Agricultural biosecurity is a significant global issue with pre-harvest crop losses of up to 15 per cent due to plant disease. A research team led by Professor Bostjan Kobe from The University of Queensland has provided new insights into the immune system of plants and advanced our understanding of the plant resistance genes that help fight against common plant diseases.

This study investigated plant responses to two significant pathogens that cause diseases in kiwifruit, potato and tomato crops. They were able to identify the interaction of two proteins which are integral to the plant’s immune response. These two receptor molecules recognise the pathogenic bacteria attacking the plant, and this recognition and interaction activated an immune response. The researchers found when pathogen disease-causing molecules are recognised by these two receptor proteins, the immune system signal to the individual infected cell to die, stopping the spread of infection and providing immunity for the entire plant.

The internationally collaborative study included investigators from the United Kingdom, New Zealand as well as the CSIRO and utilised the beamlines at the Australian Synchrotron to examine the proteins in minute detail.

This discovery will assist researchers to develop resistant crop plants and will contribute positively to the global economic and environmental challenges of food security and sustainable fibre and biofuel production. With the similarities in the way humans and plants detect and respond to disease, there could also be implications from this research for understanding human health.

Photo: Simon Williams (L) and Professor Bostjan Kobe Courtesy of Lachlan Casey.
The findings of a long-term study of biodiversity in Thailand confirm that fragmentation of forests can have rapid and devastating effects on the animals living in the region. Professor William Laurance, a recipient of an Australian Laureate Fellowship from James Cook University and Professor Corey Bradshaw, a Future Fellowship recipient from The University of Adelaide, alongside an international research team from Thailand, Singapore, China, the United States and Canada, examined forest islands created by a large hydro-electric reservoir and the impact on native small mammals.

The researchers were seeking to understand what happened to creatures in forest separated into small patches and see if there was time for conservation mechanisms, such as wildlife corridors, to reduce the detrimental effects of forest isolation. What they discovered was almost complete extinction of native species within two decades in these forest fragments. When the forest was broken up, the native mammals were extremely vulnerable the impacts of population isolation and invasive species. The Malaysian field rat, normally located in agricultural land rather than pristine forest, invaded with drastic effects when the forests were disturbed.

The speed with which animals were lost surprised researchers and ‘could have frightening implications for biodiversity’ said Professor Laurance. With tropical forests continuing to be felled and fragmented into small ‘islands’ around the world, these findings underscore the real need to conserve large intact forest areas to preserve endangered wildlife. This research will have far-reaching effects on our understanding of global biodiversity and the impact of deforestation worldwide.

Photo: Chiew Larn Reservoir. Courtesy of Tony Lynam.
The gradual diffusion of elections to almost every country around the world has generated growing concern about their integrity—elections are commonly marred by problems; the regulation of campaign finance, political broadcasting, and online voting has generated new challenges; and even minor electoral irregularities have sometimes triggered instability.

In response to this issue, Professor Pippa Norris is working to advance our understanding of the impact of democratic governance upon prosperity, welfare and peace in countries around the world. In 2013–2014, the Electoral Integrity Project, led by Professor Norris, released Why Electoral Integrity Matters (Cambridge University Press May 2014) and launched The Year in Elections 2013—an annual series covering evaluations of 73 presidential and parliamentary elections held worldwide in 66 countries. Professor Norris also co-edited Advancing Electoral Integrity (Oxford University Press, June 2014), Comparing Democracies 4 (Sage, April 2014) and edited a symposium on electoral integrity in Electoral Studies (Oct 2013).

Professor Norris is an ARC Kathleen Fitzpatrick Australian Laureate Fellow and Professor of Government and International Relations at The University of Sydney, McGuire Lecturer in Comparative Politics at the John F. Kennedy School of Government, Harvard University, and Director of the Electoral Integrity Project. The Electoral Integrity Project, based at The University of Sydney, is supported by the Australian Research Council and other foundations.

In 2014 Professor Norris was recognised by the International Political Science Association as a prominent scholar engaged in the cross-disciplinary research when awarded the Karl Deutsch prize. As a Kathleen Fitzpatrick Laureate Fellow, she is an ambassador for women in research and is engaged in encouraging early-career women researchers to stay in academia, and research on gender equality in elected office.

Photo: Participants in the 2013 Workshop of the Electoral Integrity Project, Harvard University.
CENTRE FOSTERING TALENTED RESEARCHERS

Associate Professor Andrea Morello, ARC Centre of Excellence for Quantum Computation and Communication Technology
Schemes: ARC Centres of Excellence, Discovery Projects

The race is on for the development of a scalable quantum computer that will revolutionise traditional computing, vastly speeding up the analysis of large amounts of data, and dramatically improving future calculating. This work depends on quantum physics, the field of science working at the level of elementary particles, atoms and molecules.

Associate Professor Andrea Morello is at the forefront of this ambitious research goal at the ARC Centre of Excellence for Quantum Computation and Communication Technology at The University of New South Wales. His research team has made a major breakthrough towards the achievement of quantum computing, the first in the world to demonstrate the complete quantum control of a single atom in silicon, making a fully functional quantum bit.

Receiving the 2013 Malcolm McIntosh Prize for Physical Scientist of the Year, Associate Professor Morello has gained international recognition for his role in developing the silicon components that will make quantum computing possible.

Within a few years Associate Professor Morello and his colleagues expect to have a small working prototype of a quantum computer. ‘We have created the intellectual base for the future of this technology. So this is a fantastic opportunity for Australia to get the lead in the world on a radically new technology that can revolutionise the way computations are made’, Associate Professor Morello said.

Photo: (L to R) Rachpon Kalra, Dr Juha Muhonen, Fahd Mohiyaddin, Associate Professor Andrea Morello, Jarpyd Pla, Juan Pablo Dehollain, Solomon Freer, Arne Laucht. Courtesy of Paul Henderson-Kelly
SPECIAL RESEARCH INITIATIVES
SCHEME BUILDING CAPACITY

The Special Research Initiatives (SRI) scheme provides funding for new and emerging fields of research and builds capacity in strategically important areas. In 2013–14 two initiatives funded under the SRI scheme—the Science of Learning Research Centre and the National Indigenous Research and Knowledges Network—were officially opened.

Science of Learning Research Centre

On 15 July 2013, the ARC CEO opened the Science of Learning Research Centre. The centre, which is administered by The University of Queensland, was awarded $16 million over four years (2013–2017) under the SRI scheme.

The centre is using a multidisciplinary approach to understanding the learning process and identifying new teaching practices that are based on solid scientific evidence. It has brought together education professionals and high quality researchers in education, neuroscience and cognitive psychology.

With 25 chief investigators across eight research collaborating organisations and nine partner organisations (including state education departments) the centre is well underway to building capacity in this important area of research and has commenced publishing outcomes of the research it is undertaking.

National Indigenous Research and Knowledges Network

On 27 November 2013, the ARC CEO attended the opening of the National Indigenous Research and Knowledges Network (NIRAKN). The Network, funded for $3.2 million over four years (2012–2015), is led by Professor Aileen Moreton-Robinson from the Queensland University of Technology.

NIRAKN describes itself as a ‘national, inclusive, multidisciplinary hub and spokes model network of Indigenous researchers at various stages of their careers’. The network is committed to facilitating and establishing Indigenous-led research.

NIRAKN has commenced building research capacity by bringing together over 40 network members, representing over 50 Aboriginal nations. The network includes 21 collaborating universities, the Australian Institute of Aboriginal and Torres Strait Islander Studies and five partner organisations. Since its commencement NIKRAN has:

- established a Research Capacity Building Program to mentor, train, support and engage new and emerging researchers
- provided a platform for cross-institutional and multidisciplinary research designed to build the capacity of qualified Indigenous researchers.
CHAPTER 3: OUTCOME

Photo: Launch of the Science of Learning Research Centre: (L to R) Professor Perry Bartlett (Director, Queensland Brain Institute), Professor Peter Høj (Vice Chancellor, The University of Queensland), Professor Aidan Byrne (Chief Executive Officer, Australian Research Council), The Hon Ian Walker (Queensland Minister for Science, Information Technology, Innovation and the Arts), Mr John Story (Chancellor, The University of Queensland), Professor Ottmar Lipp (former Director SLRC). Photo courtesy of Dee McGrath.

Photo: Launch of the National Indigenous Research and Knowledges Network. Photo courtesy of Associate Professor Wayne Quilliam.
USING TRIPLE J TO STOP COLLISIONS IN SPACE

Professor Steven Tingay, ARC Centre of Excellence for All-sky Astrophysics
Scheme: ARC Centres of Excellence

A combination of pop songs, talkback radio and cutting-edge science has enabled Australian astronomers to identify a way to prevent catastrophic, multi-billion dollar space junk collisions.

Team leader, Professor Steven Tingay from Curtin University says they can detect space junk by listening to the radio signals generated by FM radio station Triple J and other radio stations. The newly operational Murchison Widefield Array (MWA) has already been used to track radio waves from FM transmitters located near Perth and Geraldton bouncing off the International Space station as it passed over Western Australia, approximately 500 kilometres above the Earth’s surface.

‘We have shown that we are able to detect approximately 10 pieces of space junk simultaneously. Over time this means we are in a position to monitor a significant fraction of the space junk that is in orbit around the Earth,’ explains Professor Tingay.

‘Space debris is unpredictable and poses a significant collision risk to expensive space infrastructure, such as communication satellites. An early warning system has the potential to protect billions of dollars’ worth of vital infrastructure orbiting the Earth, but also prevent collisions that will result in more space debris being generated.’

The research is supported by the ARC Centre of Excellence for All-sky Astrophysics, administered through The University of Sydney. The Murchison Widefield Array is one of three precursor telescopes for the Square Kilometre Array project, the only low frequency precursor, and the first of the three to be fully operational.

Photo: Curtin University astronomy students building antennas. Courtesy of MWA project.
PRESERVING AUSTRALIAN INDIGENOUS HERITAGE

Professor Michael Christie, Charles Darwin University
Scheme: Linkage Infrastructure, Equipment and Facilities

For thousands of years, traditional stories have been vehicles through which Indigenous Australians have passed knowledge and language from one generation to the next. Now the internet is providing an interface not only to help Indigenous people preserve some of these stories, but also to provide an educational and research resource for academics and the broader community.

Awarded a grant under the Linkage Infrastructure, Equipment and Facilities scheme, Professor Michael Christie and Associate Professor Brian Devlin from Charles Darwin University, along with Professor Jane Simpson of The Australian National University, and colleagues from the Northern Territory Department of Education, started setting up the web-based Living Archive of Aboriginal Languages in 2012. Launched in early 2014, the project involved collaborating with language-owning communities to digitise over 800 rare and vulnerable texts and recordings in over 20 Australian Indigenous languages.

‘As a living archive that will continue to grow, this resource will facilitate connections with knowledge and language owners, most often descendants or relatives of the original storytellers,’ says Professor Christie. ‘Australia’s languages have evolved over many thousands of years to enable and enact unique human relationships with the social, cultural, technical and natural worlds. This resource will make publically available a large archive of previously unavailable resources.’

The project was awarded another Linkage Infrastructure, Equipment and Facilities grant in 2013 (adding new partners Batchelor Institute of Indigenous Tertiary Education, Northern Territory (NT) Library and NT Catholic Education Office) to expand the archive to include previously unpublished materials, increasing the indigenous languages included in the archive to over 30, as well as engaging community members, academics and schools in using and enhancing the collection.

Photo: Dr Waymamba Gaykamarju. Courtesy of Fiona Morrison, Living Archive of Aboriginal Languages
Roadside drug testing is a fairly recent phenomenon in Australia; Victoria was the first state to introduce roadside drug testing in 2004. Now over 100,000 roadside drug tests are undertaken every year. Researchers from the University of South Australia have developed a quick and reliable tool for roadside and workplace testing for illicit drugs and explosives.

The test developed by Professor Nico Voelcker and his team from the University of South Australia uses non-invasive technology (such as saliva and fingerprint testing) and is faster and more reliable than current technologies.

‘The current drug test used by police on the roadside may detect something in the system, but the sample then has to go for further testing in a forensic lab,’ Professor Voelcker says. ‘Sending a sample away for analysis at a forensic lab can often mean long delays between a positive test and laying charges.’

‘The idea with our tool is that it is rapid, sensitive and provides on the spot confirmation of the presence of drugs,’ explains Professor Voelcker. ‘The technology could also be applied beyond roadside or workplace testing to areas such as testing of elite athletes, security screening, pharmacology, and the monitoring of compliance with methadone programs.’

PhD student Taryn Guinan is currently undertaking field testing of the technology. Industry partners on the project include the Australian Federal Police, South Australian Police, New South Wales Police Force and two forensic science organisations.

Photo: Taryn Guinan.
Liver fluke is an endemic flatworm parasite found mainly in sheep and cattle, but can affect pigs, goats, alpacas, deer and even humans. The problem is estimated to cost about $3 billion a year globally and $60-90 million a year in Australia in lost production, stock deaths and prevention costs.

Professor of Agricultural Science at La Trobe University Terry Spithill is leading a Linkage Projects grant to develop a new vaccine against liver fluke infection. ‘The problem with drugs is that it’s inevitable that parasites will develop resistance, so we think a more sustainable approach is to develop a vaccine,’ says Professor Spithill.

Previous research by the team with a breed of Indonesian sheep, which are highly resistant to liver fluke infection, helped identify an immune response which kills the fluke. ‘The sheep make antibodies which bind to the surface of the liver fluke parasites and also produce white blood cells which kill the parasite,’ explains Professor Spithill. ‘We’ve identified 229 potential protein molecules on the fluke’s surface and we’re now sifting through those molecules to find out which one or ones will induce the required immune response to kill the parasite when we vaccinate an animal.’

Virbac, a company focused on vaccine manufacture is collaborating on the project. ‘By working with a company like Virbac we can harness their experience with vaccine manufacturing and formulation. We’re providing the proteins that we think might be the best candidates; Virbac are providing the vaccine formulation experience and helping to fund the work.’

The work is being carried out at the new state-of-the-art AgriBio Centre at La Trobe University.
Australian Synchrotron scientists and conservators from the State Library of New South Wales are attempting to establish the origin and authorship of some of the earliest scientific drawings of Australian flora and fauna. The exquisitely-detailed drawings depicting Australian birds, plants and fish date from 1790 to 1792, the early days of European settlement in New South Wales and include intricate gold, silver and brass leaf work with watercolours to create iridescent effects.

‘The use of intricate leaf work with watercolours raised doubts over where the drawings were produced,’ explains Kate Hughes, conservator at the State Library of New South Wales, where the drawings are held. ‘The lack of resources in the colony caused questions about the likelihood that gold would be available for the artists at the time. This led to the hypothesis that the works were produced as copies in India where the technique was common.’

The drawings themselves are very delicate and cannot be touched making analysis difficult. Using the x-ray fluorescence microscopy beamline at the Australian Synchrotron, Dr Daryl Howard was able to examine the very fine details of the drawings and map the metallic elements of the drawings to determine their chemical composition. Preliminary results reveal that the gold leaf used in the paintings is high quality with very few impurities. ‘This is a really strong indication that the gold was refined in the UK or Europe,’ says Ms Hughes.

The Australian Synchrotron is funded through the ARC SRI in Synchrotron Science in partnership with the Victorian State Government, the Science and Industry Endowment Fund, the New Zealand Synchrotron Group Limited and the Australian Nuclear Science and Technology Organisation.

Photo: Kate Hughes and Dr Daryl Howard. Courtesy of Nancy Mills, Australian Synchrotron.
HUMAN RESISTANCE TO BACTERIAL DISEASES LINKED TO CORAL ANCESTRY

Professor David Miller, James Cook University
Scheme: ARC Centres of Excellence

Researchers at the ARC Centre of Excellence for Coral Reef Studies have found three genes in staghorn corals which show a very fast, strong immune response to the presence of bacteria. The same genes also occur in mammals, including humans.

‘It is early days, but it certainly looks as if key aspects of our ability to resist bacteria are extremely ancient and may have been pioneered by the ancestor of corals,’ says team leader Professor David Miller. ‘We were quite surprised at how rapidly and strongly these three genes in particular reacted to the presence of bacterial proteins. It was spectacular.’

The main goal of the research is to better understand the mechanisms by which most corals resist attack by bacteria and viruses – an urgent task in view of the upsurge in coral diseases around the world, which researchers attribute to the impact of human activity on the oceans and coral reefs.

‘By better understanding the basis of coral immunity we may be able to understand what is causing the pandemic of coral diseases and how human activity is connected to it. This will hopefully lead us to better ways of managing our reefs, reduce the impact of disease, and give corals a better chance of survival during a period of major climatic and environmental change.’

Photo: Acropora formosa, a staghorn coral.
WEED STUDY PROVIDES INSIGHT INTO ALZHEIMER’S

Professor Jim Whelan, ARC Centre of Excellence for Plant Energy Biology
Scheme: ARC Centres of Excellence

‘There’s a need to double food production in the next thirty to forty years, the problem is that all increases in plant productivity in the last twenty to thirty years have required a large input of resources, water and fertilizers. This approach is very costly and limiting, so we need to come up with a new way to make plants more efficient and increase yield’, states Professor Jim Whelan from La Trobe University, a Chief Investigator with the ARC Centre of Excellence for Plant Energy Biology (administered through The University of Western Australia).

Professor Whelan is looking at how plants might be grown more efficiently, particularly reducing stress and disease and therefore increasing production. As part of an international collaboration he has identified and characterized a new enzyme found in thale cress, a small garden weed. The enzyme destroys small proteins in the plant’s cells that would otherwise become toxic.

While the work on the new enzyme is furthering understanding of disease in plants, it could also assist our understanding of the equivalent enzyme in human cells. ‘Documenting the biological pathways which lead to enzymes breaking down proteins and peptides is essential to understanding disease in animals as well as plants,’ states Professor Whelan. ‘Alzheimer’s occurs because small proteins that would otherwise become toxic are no longer effectively or efficiently removed from brain cells.’

Photo: Dr Monika Murcha.
In 2013 the ARC commissioned ACIL Allen Consulting to undertake an independent benefits realisation review of ERA. The review explored the monetary and non-monetary benefits flowing from ERA. It found that ‘ERA helped to increase the social rate of return of research, generate cost savings, increase university revenue, enhance economic activity and improve accountability, transparency and policy-making’ (Benefits Realisation Review of ERA, Final report (September 2013)).

The review identified three key areas where ERA is having a significant influence:
- improved research performance
- enhanced university planning strategy and operation
- better accountability, transparency and policy making.

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Source: ACIL Allen Consulting

The review report is published on the ARC website.
CONTRIBUTION OF ERA TO MAPPING RESEARCH ACTIVITY IN AUSTRALIA

The Australian Renewable Energy Agency (ARENA) is an independent statutory agency tasked with improving the competitiveness and supply of renewable energy in Australia. The study commissioned by ARENA is a collaboration by the ARC with the Commonwealth Scientific and Industrial Research Organisation (CSIRO) which provides ARENA with detailed analyses of the scope and focus of R&D activity by Australia’s universities in renewable energy technologies (RETs).

The study draws significantly on the ERA data set and the techniques which have been developed by the ARC for the measurement of research quality in ERA.

The study finds that research into RETs in Australia is primarily underpinned by a small number of Engineering disciplines (most notably Materials Engineering, and Electrical and Electronic Engineering). In all cases, the research activity in these disciplines is growing as indicated by the increasing numbers of publications reported between ERA 2010 and ERA 2012.

The overall quality of each discipline is also improving over time, with larger proportions of the universities that are active in these disciplines judged to be performing research at world standard or higher in ERA 2012 than in 2010. Within these underpinning disciplines, RETs research performs strongly on key citation indicators suggesting that while the total output is relatively focussed, RETs research is a pocket of national strength.

The study indicates a strong set of research disciplines underpinning Australian universities’ R&D into renewable energy technologies, and shows that over time this activity is increasing in terms of size and quality.

The study is published on the ARENA website at <www.arena.gov.au>.

ERA data can be used as a tool to guide strategic planning, including aligning research strengths with industry, regional and national priorities to maximise the benefits of public investment in research.
In 2013–14 the ARC commenced work on development of a statement that clearly articulated the agency’s support for the research workforce through the NCGP. This included researchers from all career levels and key groups such as women, Indigenous and international researchers.

To assist this process, the ARC invited Australian Laureate Fellows to participate in an external reference group to provide input into the process. The fellows completed a series of surveys covering gender and career balance, career stage and international issues. They provided feedback on their own experiences as well as their views on the role of the ARC in addressing these issues.

As a result of this process, in February 2014 the ARC released a Research Opportunity and Performance Evidence (ROPE) statement on its website to promote a clearer understanding of the ARC’s position on ROPE. The ARC first introduced ROPE under the Discovery Projects scheme of the NCGP for funding commencing in 2011 and subsequently under all other schemes. It replaced the selection criterion of ‘track record relative to opportunities’.

ROPE was introduced to help provide a more realistic consideration of a researcher’s capabilities and assist those who have had career interruptions for family and other reasons.

The statement aims to encourage consistent presentation and assessment of NCGP proposals by providing guidance to assessors and researchers on the application of ROPE.
The ARC works closely with other research funding agencies on matters of mutual interest including, where appropriate, to develop consistent or complementary policies.

To respond to the increased interest in measuring the societal benefits from research and coordinating better reporting and showcasing of research outcomes, in August 2012 a number of publicly funded research agencies established a working group. The working group is aiming to develop a common understanding of terminology, approaches, and reporting of research impact. The agencies that were active participants of the working group during 2013–14 included:

- Australian Institute of Aboriginal and Torres Strait Islanders Studies
- Australian Institute of Marine Science
- Australian Nuclear Science and Technology Organisation
- Australian Research Council
- Bureau of Meteorology
- CSIRO
- Defence Science and Technology Organisation
- Geoscience Australia
- National Health and Medical Research Council

In August 2013, the working group publicly released a document containing a definition of research impact, guiding principles and a glossary of common terms. This document is available on the ARC website. Work will continue in 2014–15 to identify existing and new data that can be used to verify the benefits of research.
INTERNATIONAL STRATEGY

The ARC plays a significant role in supporting international collaboration, by maintaining a strong presence within the international research community and providing funding opportunities that bring together Australian and international researchers and organisations.

During 2013–14 the ARC reviewed its international strategy. The review considered the possibility of, and options for, strengthening international links, as well as improving the visibility and effectiveness of ARC support for international collaboration within NCGP funding schemes.

As a result of opportunities identified through the review the ARC established a new ‘International’ page on the ARC website. The page provides information and statistics on recent international collaborations through ARC funding; updates on the ARC’s international presence (including recent discussions with overseas agencies and participation in global forums); and information on funding opportunities for international collaboration.

The ARC continued to strengthen its international links during 2013–14 by increasing its international engagement through discussions with overseas and domestic organisations. It also analysed options for improving the effectiveness of ARC support for international collaboration using:
- input from discussions with overseas agencies and domestic organisations
- a survey on international collaboration.

In May 2014, the ARC Chief Executive Officer (CEO) participated in the 2014 Annual Meeting of the Global Research Council. The council involves approximately 70 counterpart science and research councils from around the world. Through participation in the council, the ARC is an active player in addressing international issues in research funding, including open access and sustainability of the research workforce.
The ARC actively engaged with stakeholders on developments in this area and continued to refine its advice and key messages to ensure consistency in the implementation of the policy across the sector. In particular, the ARC:

- worked closely with the National Health and Medical Research Council (NHMRC) as well as the Council of Australian University Librarians and the Australian Open Access Support Group
- participated in various seminars, workshops and forums across the country
- participated in Open Access Week 2013—Professor Aidan Byrne and Professor Warwick Anderson, CEO of the NHMRC promoted their agencies’ open access policies at the launch
- participated in Queensland University of Technology’s Open Access and Research Conference 2013—Professor Byrne gave the opening address.

In January 2014, the ARC surveyed Australian universities to gain a better understanding of institutional preparedness and capacity, as well as sector-wide consistency in approach, to managing the requirements under the policy. The results of this consultation will inform the development of further advice, and dissemination of good practice, to the sector.

In recognition of the truly global nature of open access, in 2013–14 the Global Research Council (GRC) deemed open access as a key issue relevant to the international funding landscape. Through ARC’s participation in the GRC, the agency has contributed to global efforts to maximise the progress and benefits of open access, and to minimise any barriers to international research collaboration.
ACCESSIBLE DATA

Taking into account the wide variety of practices across disciplines for the generation, dissemination and storage of research data, the ARC is committed to ensuring that data generated through ARC-funded research is as accessible as possible.

The ARC is committed to maximising the benefits from ARC-funded research, including facilitating greater access to research data. In line with its responsibilities outlined in the Australian Code for the Responsible Conduct of Research (2007) and international best practice, since 2007 the ARC has encouraged researchers to deposit data arising from research projects in publicly accessible repositories.

The ARC considers researchers, in consultation with their institutions, to be responsible for considering the management and future potential of their research data. While the ARC is not mandating open data, researchers are strongly encouraged to consider the ways in which they can best manage, store, disseminate and reuse data generated through ARC-funded research, taking into account the differences that may exist between institutions, disciplines and research projects.

In January 2014, the ARC continued to foster a culture of good data management and practices by clarifying its data management expectations. A new requirement for researchers to outline how they plan to manage research data arising from ARC-funded research was added to the funding rules and supporting documentation of Discovery Program schemes for 2014 and 2015. The requirement forms part of the application process to receive funding. In developing and communicating its new data management requirements the ARC worked closely with the Australian National Data Service.
Dr Sandra Tanz, The University of Western Australia, a Discovery Early Career Researcher Award recipient, is analysing plant samples.

Photo courtesy of Matt Galligan.
DESCRIPTION

The Discovery Program supports the growth of Australia’s research and innovation capacity, which generates new knowledge resulting in the development of new technologies, products and ideas, the creation of jobs, economic growth and an enhanced quality of life in Australia.

The objectives of the Discovery Program are to:
- support excellent, internationally competitive research by individuals and teams that will produce high quality outcomes
- build Australia’s research capacity through supporting and facilitating research training and career opportunities for excellent Australian and international researchers
- support research in priority areas that will deliver national benefits
- enhance research capacity and outcomes through support for international collaboration.

The program comprises the following funding schemes:
- Australian Laureate Fellowships
- Discovery Early Career Researcher Award
- Discovery Indigenous
- Discovery Projects
- Future Fellowships.

Performance data for the Discovery Program, unless otherwise indicated, relates to funding commencing in the 2013–14 financial year (regardless of the date of announcement). Further information on the Discovery Program (including schemes, grant statistics and additional performance data) is provided in Part 5, Appendix 1.

INFLUENCES ON PERFORMANCE IN 2013–14

Key Discovery Program developments during 2013–14 included:
- the announcement of ongoing funding for the Future Fellowships scheme
- the ongoing focus on streamlining grant processes including the consolidation of the Discovery Program funding rules into a single document.
## SUMMARY OF PERFORMANCE

2013–14 performance is summarised in Table 4.1.

### TABLE 4.1: DISCOVERY PROGRAM, PERFORMANCE SUMMARY

<table>
<thead>
<tr>
<th>Deliverables</th>
<th>PERFORMANCE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of grants awarded</td>
<td>1131</td>
<td>49</td>
</tr>
<tr>
<td>Number of researchers supported (investigators named in funded proposals)</td>
<td>2339</td>
<td>50</td>
</tr>
<tr>
<td>Amounts awarded to administering organisations</td>
<td>$538 033 432</td>
<td>50</td>
</tr>
<tr>
<td>Policy advice relating to research and research training</td>
<td>Achieved</td>
<td>50</td>
</tr>
</tbody>
</table>

### Key performance indicators

<table>
<thead>
<tr>
<th>Output or Indicator</th>
<th>Performance</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outputs and outcomes arising from ARC-supported research are of a high quality and produce national benefits</td>
<td>2/2 targets met</td>
<td>52</td>
</tr>
<tr>
<td>ARC funding supports excellent researchers</td>
<td>2/2 targets met</td>
<td>53</td>
</tr>
<tr>
<td>ARC-supported research contributes significantly to high quality research training</td>
<td>2/2 targets met</td>
<td>54</td>
</tr>
<tr>
<td>ARC fellowship and award schemes attract high quality international applicants</td>
<td>1/1 target not met</td>
<td>55</td>
</tr>
<tr>
<td>ARC-funded research makes a significant contribution to research activity and capability in areas of national need</td>
<td>2/2 targets met</td>
<td>56</td>
</tr>
<tr>
<td>There is a high level of collaboration between ARC-funded researchers and those within other components of the national and international innovation systems</td>
<td>1/1 target met</td>
<td>57</td>
</tr>
</tbody>
</table>
DELIVERABLES

Through the Discovery Program schemes, the ARC delivers funding for individual research projects and research fellowships and awards. Funding is awarded to administering organisations on the basis of competitive peer review processes involving Australian and international experts.

TABLE 4.2: DISCOVERY PROGRAM, DELIVERABLES

<table>
<thead>
<tr>
<th>DELIVERABLE</th>
<th>RESULT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of grants awarded</td>
<td>2013–14: 1131</td>
</tr>
<tr>
<td></td>
<td>2012–13: 1168</td>
</tr>
<tr>
<td></td>
<td>2011–12: 1306</td>
</tr>
<tr>
<td>Number of researchers supported (investigators named in funded proposals)</td>
<td>2013–14: 2339</td>
</tr>
<tr>
<td></td>
<td>2012–13: 2340</td>
</tr>
<tr>
<td></td>
<td>2011–12: 2537</td>
</tr>
<tr>
<td>Amounts awarded to administering organisations</td>
<td>2013–14: $538 033 432</td>
</tr>
<tr>
<td></td>
<td>2012–13: $528 838 000</td>
</tr>
<tr>
<td></td>
<td>2011–12: $547 343 000</td>
</tr>
<tr>
<td>Policy advice relating to research and research training</td>
<td>2013–14: Achieved</td>
</tr>
<tr>
<td></td>
<td>2012–13: Achieved</td>
</tr>
<tr>
<td></td>
<td>2011–12: Achieved</td>
</tr>
</tbody>
</table>

NUMBER OF GRANTS AWARDED

The ARC awarded 1131 new grants under the Discovery Program for funding commencing in 2013–14 comprising:
- 17 Australian Laureate Fellowships
- 200 Discovery Early Career Researcher Awards
- 10 Discovery Indigenous grants
- 703 Discovery Projects grants
- 201 Future Fellowships.

The number of new grants awarded in 2013–14 is similar to that awarded in 2012–13 (see Figure 4.1). The higher number of grants awarded in 2011–12 reflects the larger number of Discovery Early Career Researcher Awards allocated in that year, the first year of the scheme’s operation, and the allocation of 50 Super Science Fellowships. The Super Science Fellowships scheme was a special initiative of the Australian Government which operated for funding commencing in 2010 and 2011.

Details of Discovery Program grants awarded for funding commencing in 2013–14 are provided on the ARC website.
NUMBER OF RESEARCHERS SUPPORTED
The 1131 new grants awarded for commencement in 2013–14 involved 2339 named researchers. The named researchers included 440 recipients of individual fellowships or awards (comprising Australian Laureate Fellowships, Discovery Early Career Researcher Awards, Discovery Indigenous Awards under the Discovery Indigenous scheme, Discovery Outstanding Researcher Awards under the Discovery Projects scheme, and Future Fellowships). Other named researchers included:
- chief investigators under the Discovery Indigenous scheme
- chief investigators and partner investigators under the Discovery Projects scheme.

AMOUNTS AWARDED TO ADMINISTERING ORGANISATIONS
Total funding of $538.0 million was awarded by the ARC to the 1131 new grants under the Discovery Program for funding commencing in 2013–14. The total funding awarded comprised:
- $47.4 million over five years for the Australian Laureate Fellowships scheme
- $75.8 million over three years for the Discovery Early Career Researcher Award scheme
- $4.9 million over three years for the Discovery Indigenous scheme
- $257.6 million over three years for the Discovery Projects scheme
- $152.3 million over four years for the Future Fellowships scheme.

The total amount of funding awarded in 2013–14 is similar to that awarded in 2012–13 and 2011–12 (see Figure 4.2).

POLICY ADVICE RELATING TO RESEARCH AND RESEARCH TRAINING
In 2013–14 the ARC provided advice and engaged in discussions on a range of policy matters relevant to the Discovery Program. During the year, for example, the ARC commenced development of a Research Workforce statement aimed at articulating clearly the ARC’s support for researchers. A case study in Chapter 3 (page 41) provides more information about this statement.
Figures 4.1 and 4.2 illustrate the distribution of proposals and funding awarded under the Discovery Program from 2011-12 to 2013-14. The figures break down the funding by different schemes: DECRA (Discovery Early Career Researcher Award), DI (Discovery Indigenous), DP (Discovery Projects), FL (Australian Laureate Fellowships), FS (Super Science Fellowships), FT (Future Fellowships).

Schemes: DECRA (Discovery Early Career Researcher Award), DI (Discovery Indigenous), DP (Discovery Projects), FL (Australian Laureate Fellowships), FS (Super Science Fellowships), FT (Future Fellowships)
OBJECTIVE—TO SUPPORT EXCELLENT RESEARCH

DESCRIPTION
Through the Discovery Program, the ARC aims to support Australia’s highest quality research conducted in higher education institutions and other eligible organisations. To ensure excellent research is funded, the ARC uses a rigorous assessment process involving academic peer review.

In 2013–14 the ARC:
- amended the application form asking researchers to provide a statement indicating the contribution that their research could make to the Australian economy, society, culture, national security, public policy or services, health, the environment, or quality of life to better convey the benefits of publicly funded research.

PERFORMANCE

Key Performance Indicator 1: Outputs and outcomes arising from ARC-supported research are of a high quality and produce national benefits (KPI 1.1 in ARC strategic plan)

<table>
<thead>
<tr>
<th>MEASURE 1</th>
<th>EVIDENCE OF IMPACT OF ARC-FUNDED RESEARCH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target</td>
<td>Significantly exceeds benchmarks where available</td>
</tr>
<tr>
<td>Result</td>
<td></td>
</tr>
<tr>
<td>2013–14:</td>
<td>Met</td>
</tr>
<tr>
<td>2012–13:</td>
<td>Not measured</td>
</tr>
<tr>
<td>2011–12:</td>
<td>Not measured</td>
</tr>
</tbody>
</table>

In 2013–14 the ARC used the ERA 2012 results as an indicative measure of the quality of ARC-funded research. The ERA results showed that 72.4 per cent of Category 1 research income was associated with assessed units of evaluation rated above or well above world standard. Category 1 research income includes all research income universities receive from Australian Competitive Grants. The funds awarded by the ARC and the National Health and Medical Research Council form the bulk of this income.

The ARC did not assess this measure in 2012–13 or 2011–12. Previously the ARC commissioned a bibliometric study to measure the citation impact of ARC-funded research relative to the Australian and world averages. The ARC released the last study in 2009 and used the results to report on performance in the ARC Annual Report 2009–10.

During 2013–14 the ARC continued to collect information on the outputs of ARC-funded research projects from final reports submitted to the agency. Under the Discovery Program, research projects and fellowships initially funded in 2009 produced on average 15.2 academic outputs per research project, and a total of 62 commercialisation outputs (see Table A1.3).
MEASURE 2
OUTCOMES ARISING FROM ARC-FUNDED RESEARCH THAT PROVIDE SOCIAL, ECONOMIC, ENVIRONMENTAL AND CULTURAL BENEFITS

<table>
<thead>
<tr>
<th>Target</th>
<th>Evidence of benefits arising from the outcomes of ARC-funded research</th>
</tr>
</thead>
<tbody>
<tr>
<td>Result</td>
<td></td>
</tr>
<tr>
<td>2013–14:</td>
<td>Met</td>
</tr>
<tr>
<td>2012–13:</td>
<td>Met</td>
</tr>
<tr>
<td>2011–12:</td>
<td>Met</td>
</tr>
</tbody>
</table>

The research case studies in Chapter 3 provide examples of the diverse outcomes produced by ARC-funded research in 2013–14. The case studies document the social, economic, environmental and cultural benefits generated by ARC-funded research.

Key Performance Indicator 2: ARC funding supports excellent researchers (KPI 1.2 in ARC strategic plan)

MEASURE 3
EXTERNAL RECOGNITION OF THE ACHIEVEMENTS OF ARC-FUNDED RESEARCHERS

| Target                          | Prestigious prizes and awards are received by ARC-funded researchers |
|---------------------------------|                                                                     |
| Result                          |                                                                       |
| 2013–14:                        | Met                                                                   |
| 2012–13:                        | Met                                                                   |
| 2011–12:                        | Met                                                                   |

In 2013–14 ARC-funded researchers were the recipients of national and international prizes and awards for their research (see Part 5, Appendix 3 for listing of examples). Researchers at all career levels were recognised for their research excellence.

MEASURE 4
EVIDENCE OF IMPACT OF RESEARCH CONDUCTED BY ARC-FUNDED FELLOWS

<table>
<thead>
<tr>
<th>Target</th>
<th>Exceeds benchmarks where available</th>
</tr>
</thead>
<tbody>
<tr>
<td>Result</td>
<td></td>
</tr>
<tr>
<td>2013–14:</td>
<td>Met</td>
</tr>
<tr>
<td>2012–13:</td>
<td>Not measured</td>
</tr>
<tr>
<td>2011–12:</td>
<td>Not measured</td>
</tr>
</tbody>
</table>

Examples of outcomes arising from research conducted by ARC-funded fellows are provided in the case studies in Chapter 3.
OBJECTIVE—TO SUPPORT RESEARCH TRAINING AND CAREER OPPORTUNITIES

DESCRIPTION
The ARC provides support for researchers at all career stages through fellowship and awards administered under the Discovery Program. In addition:

- the Australian Laureate Fellowship scheme provides support for research training with funding provided for up to two Postdoctoral Research Associates and two Postgraduate Researchers
- allowable budget items under the Discovery Projects scheme include salaries for Higher Degree by Research students and postdoctoral researchers.

In 2013–14:
- the ARC commenced work on a statement about its support for the research workforce. Following consultations with the sector undertaken as part of this process, the ARC published a Research Opportunity and Performance Evidence statement in February 2014. Further information is provided in the case study on page 41.

PERFORMANCE

Key Performance Indicator 3: ARC-supported research contributes significantly to high quality research training (KPI 1.3 in ARC strategic plan)

<table>
<thead>
<tr>
<th>MEASURE 5</th>
<th>PROPORTION OF ARC-FUNDED RESEARCHERS WHO ARE EARLY CAREER RESEARCHERS (WITHIN FIVE YEARS OF COMPLETION OF THEIR PHD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target</td>
<td>Greater than 20 per cent</td>
</tr>
<tr>
<td>Result</td>
<td>2013–14: 22.3 per cent</td>
</tr>
<tr>
<td></td>
<td>2012–13: 21.2 per cent</td>
</tr>
<tr>
<td></td>
<td>2011–12: 22.0 per cent</td>
</tr>
</tbody>
</table>

Under the Discovery Program funding schemes, early career researchers comprised 22.3 per cent of researchers funded in 2013–14. This includes the 201 researchers supported through the ARC’s dedicated funding scheme for early career researchers—the Discovery Early Career Researcher Award scheme—and Chief Investigators funded under other schemes that are within five years of completion of their PhD. This proportion has remained relatively constant in recent years.
MEASURE 6 NUMBER OF RESEARCH STUDENTS SUPPORTED THROUGH ARC FUNDING

<table>
<thead>
<tr>
<th>Target</th>
<th>An average of three per grant (Discovery Projects)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Result*</td>
<td>2013–14: 4.2</td>
</tr>
</tbody>
</table>

* A new measure in 2013–14

Through the Discovery Program funding schemes, ARC-funded research supports high-quality research training. Indicative data collected from final reports submitted to the ARC showed that each Discovery Projects grant initially funded in 2009 provided support for an average of 4.2 research students. This includes both domestic and international postgraduates (see Part 5, Appendix 1, Table A1.4)

Key Performance Indicator 4: ARC fellowship and award schemes attract high quality international applicants (KPI 1.4 in ARC strategic plan)

MEASURE 7 PROPORTION OF FELLOWSHIPS AND AWARDS THAT ARE AWARDED TO INTERNATIONAL APPLICANTS (FOREIGN NATIONALS AND RETURNING AUSTRALIANS)

<table>
<thead>
<tr>
<th>Target</th>
<th>Greater than 28 per cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Result*</td>
<td>2013–14: 26.8 per cent</td>
</tr>
<tr>
<td></td>
<td>2012–13: 24.4 per cent</td>
</tr>
</tbody>
</table>

* Not measured in 2011–12

In 2013–14 international applicants (including returning Australians and foreign nationals) were the recipients of 26.8 per cent of Discovery Program fellowships and awards. The result is below the target of 28 per cent which was set based on the results achieved in 2011–12. The 2011–12 financial year included the inaugural selection round of the Discovery Early Career Researcher Award scheme under which 277 awards were made (compared to the approximately 200 awards made under subsequent selection rounds).
OBJECTIVE—TO SUPPORT RESEARCH IN PRIORITY AREAS

DESCRIPTION

Under the Discovery Program funding schemes researchers are invited to indicate whether their research addresses an area of Government priority. In addition, under the Future Fellowships scheme proposals are encouraged in targeted priority areas.

In 2013–14:

- the Australian Government identified new Strategic Research Priorities (SRPs) for government-funded research (replacing the National Research Priorities (NRPs)). The year 2013–14 was identified as a year of transition facilitating final reporting against the NRPs and the establishment of arrangements to report against the new SRPs.

- the targeted research areas of national significance identified for the 2013 Future Fellowships selection round were: bioinformatics; computer system security; Indigenous health and wellbeing; managing innovation, renewable energy and green technology; pattern recognition and data mining; safeguarding Australia (especially electronic security, surveillance and detection); understanding culture and communities.

PERFORMANCE

Key Performance Indicator 5: ARC-funded research makes a significant contribution to research activity and capability in areas of national need (KPI 1.5 in ARC strategic plan)

<table>
<thead>
<tr>
<th>MEASURE 8</th>
<th>PROPORTION OF FUNDED PROPOSALS THAT ADDRESS NATIONAL RESEARCH PRIORITIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target</td>
<td>Greater than 85 per cent</td>
</tr>
<tr>
<td>Result</td>
<td>2013–14: 91.5 per cent TARGET MET</td>
</tr>
<tr>
<td></td>
<td>2012–13: 92.0 per cent</td>
</tr>
<tr>
<td></td>
<td>2011–12: 91.1 per cent</td>
</tr>
</tbody>
</table>

Of the new proposals funded under the Discovery Program in 2013–14, 91.5 per cent indicated that they involved research relevant to one of the Australian Government’s National Research Priorities. Research projects within the National Research Priority area of ‘Frontier technologies for building and transforming Australian industries’ made up the largest proportion of funded proposals at 41.8 per cent.

<table>
<thead>
<tr>
<th>MEASURE 9</th>
<th>EVIDENCE OF IMPACT IN NATIONAL RESEARCH PRIORITY AREAS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target</td>
<td>Examples of impact in NRP areas</td>
</tr>
<tr>
<td>Result</td>
<td>2013–14: Met TARGET MET</td>
</tr>
<tr>
<td></td>
<td>2012–13: Met</td>
</tr>
<tr>
<td></td>
<td>2011–12: Met</td>
</tr>
</tbody>
</table>

Examples of outcomes arising from ARC-funded research in National Research Priority areas are provided in the case studies in Chapter 3.
OBJECTIVE—TO SUPPORT INTERNATIONAL COLLABORATION

DESCRIPTION
Under the Discovery Program, the ARC provides support for international collaboration through a number of mechanisms including:

- International Collaboration Awards under the Discovery Projects scheme to increase opportunities for collaboration between researchers, research teams and/or research centres in Australia and overseas
- Funding up to a specified limit for overseas travel by chief investigators, fellows and other project personnel and by partner investigators based overseas to travel to Australia.

During 2013–14:
- the ARC improved the visibility of the international aspects of its funding schemes by improving the accessibility and depth of information about international collaboration opportunities on its website and through international engagement activities. The case study on page 43 provides further information about the ARC’s international strategy.

PERFORMANCE

Key Performance Indicator 6: There is a high level of collaboration between ARC-funded researchers and those within other components of the national and international innovation systems (KPI 1.6 in ARC strategic plan)

<table>
<thead>
<tr>
<th>MEASURE 10</th>
<th>PROPORTION OF PROJECTS INVOLVING INTERNATIONAL COLLABORATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target</td>
<td>Greater than 65 per cent</td>
</tr>
<tr>
<td>Result</td>
<td>2013–14: 65.3 per cent</td>
</tr>
<tr>
<td></td>
<td>2012–13: 65.0 per cent</td>
</tr>
<tr>
<td></td>
<td>2011–12: 67.6 per cent</td>
</tr>
</tbody>
</table>

A total of 65.3 per cent of the 1131 new projects funded in 2013–14 under the Discovery Program funding schemes involved international collaboration. The proportion varied across the individual funding schemes with the Future Fellowships scheme recording the highest levels of international engagement. In total the new projects nominated 1617 instances of international collaboration with over 120 countries.

In the Discovery Projects selection round for funding commencing in 2014, 91 proposals were awarded one or more International Collaboration Awards.
DISCOVERY RESEARCH COMMENCING IN 2013–14
THE MANGROVE CARBON PUMP

Dr Isaac R Santos, Southern Cross University
Discovery Early Career Researcher Award scheme

Mangrove forests are highly productive coastal ecosystems which play a key role in the marine carbon cycle. Many of these forests are under threat from drainage and deforestation to make room for urban development and aquaculture as well as increasing stress from pollution. Globally, mangroves are considered important carbon sinks (natural reservoirs that accumulate and store carbon). While scientists know how much carbon is being absorbed by the mangrove trees, the quantity of carbon that is subsequently lost to the ocean and how this occurs is unclear.

Associate Professor Isaac Santos, from Southern Cross University, has been awarded funding under the Discovery Early Career Researcher Award scheme for an innovative project investigating carbon pathways in mangroves, using a combination of new experimental and modelling approaches.

His project will test the hypothesis that carbon is transferred into the soil around mangroves, then into the groundwater via crab burrows before seeping into the ocean. It aims to investigate carbon and greenhouse gas cycling in six Australian mangrove tidal creeks and determine whether underground respiration can close imbalanced mangrove carbon budgets. This research will contribute to closing a significant gap in our understanding of the coastal carbon cycle and the ways in which mangroves influence nearby coastal ecosystems.

Photo: Field work crew heading into Hinchinbrook Island. Courtesy of Paul Macklin.
DISCOVERY RESEARCH COMMENCING IN 2013–14
HISTORY OF AUSTRALIAN MINING

Dr Clare Wright, La Trobe University
Future Fellowships scheme

Though Australia’s past economic prosperity was said to be riding on the sheep’s back, mining has been a vital industry for Australia’s economic progress. The recent resources boom—and slowdown—has once again centred mining in the Australian economy and consciousness. Yet there has not been an updated national history of mining for fifty years.

Dr Clare Wright from La Trobe University, with funding provided through the Future Fellowships scheme, will redress this deficit by compiling a new history of Australian mining that examines key events in Australia’s past through the social and cultural settings of mining communities, environments and industries.

The story of mineral exploration and exploitation will receive a fresh assessment of its social, cultural and political impact in Australia. By examining records and narrative descriptions of past encounters around mining sites and communities, this research will explore the complex interactions of people, land and governments. It will provide an innovative new narrative of the multiple and diverse historical protagonists and processes created by Australia’s geological wealth.

Dr Wright was recently awarded the 2014 Stella Prize for her book, *The Forgotten Rebels of Eureka*, based on her ARC-funded postdoctoral research into the role of women at the Eureka Stockade.

Photo: Dr Clare Wright. Courtesy of © V. Cummins
From deep within the Earth, plumes of molten rock can rise up and produce enormous eruptions on the surface of the planet. Despite the size of these plumes and their role in global mass extinctions, how these molten rocks drive continental movement is not well understood.

Building on her previous work for which she was awarded a 2013 L’Oreal Women in Science Fellowship, Dr Joanne Whittaker from the Institute for Marine and Antarctic Studies at the University of Tasmania aims to further our knowledge of how the internal workings of the Earth influence and interact with geological processes on the surface. As part of her Discovery Early Career Researcher Award, she will use global and Australian geological and geophysical data combined with modelling systems to investigate the impact of plumes on determining continental and marine landscapes through geological time.

Understanding how these fundamental processes shaped Earth’s surface in the past is key to predicting how these processes shape the environmentally important, and resources rich, continental margins and ocean basins. The Australian case studies areas in the Eastern Indian Ocean and Southwest Pacific are of economic interest to Australia, for their natural reserves and this research will enable efficient exploration and discovery of deep Earth resources to the benefit of the Australian economy.
While bushfires have always been an inherent feature of the Australian environment, in recent years there has been an increase in the number and severity of bushfires. These bushfires have resulted in loss of life and substantial property damage, with significant social, economic and ecological follow-on effects.

Associate Professor Jason Sharples, a Discovery Indigenous scheme recipient, is investigating eruptive bushfire behaviour, an extremely dangerous form of fire activity with a sudden and unexpected increase in intensity and the rate of spread, also known as fire blow up. While eruptive bushfires are a global phenomenon, a lack of understanding of dynamic fire behaviour and the effects of terrain limits the ability to predict the onset of eruptive fire events, which can pose major threats to firefighter safety and hamper bushfire suppression.

Based at The University of New South Wales Canberra, Associate Professor Sharples is examining the key physical mechanisms that cause this type of fire behaviour, using laboratory experiments and mathematical modelling to analyse the role the geometry of the terrain plays in triggering eruptive bushfire. The aim of his research is to provide better advice to bushfire authorities and improve the safety and effectiveness of firefighting efforts.

Associate Professor Sharples was a finalist in the 2013 Eureka Prizes for his ground-breaking work on extreme fire behaviour.

Photo: Associate Professor Jason Sharples.
Dr Kerry Wilkinson, The University of Adelaide, is a member of the Industrial Transformation Training Centre for Innovative Wine Production.

Photo courtesy of The University of Adelaide.
DESCRIPTION

The Linkage Program supports research partnerships within Australia and internationally to encourage the exchange and transfer of knowledge, ideas and skills as a basis for building capacity to deliver high quality research outcomes and secure commercial and other benefits of research.

The objectives of the Linkage Program are to:
- support excellent collaborative research initiatives involving partnerships between higher education organisations and with other sectors, in Australia and internationally
- foster research training and career opportunities that enable excellent Australian and international researchers and research students to gain experience working in industry settings
- support collaborative research in priority areas that will deliver national benefits
- enhance capacity to deliver national benefits by investing in large-scale collaborative research programs.

The program comprises the following schemes:
- ARC Centres of Excellence
- Industrial Transformation Research Hubs
- Industrial Transformation Training Centres
- Linkage Infrastructure, Equipment and Facilities
- Linkage Learned Academies Special Projects
- Linkage Projects
- Special Research Initiatives.

The ARC also supports co-funded research centres under the Linkage Program. Performance data for the Linkage Program, unless otherwise indicated, relates to funding commencing in the 2013–14 financial year (regardless of the date of announcement). Further information on the Linkage Program (including schemes, grant statistics and additional performance data) is provided in Part 5, Appendix 2.

INFLUENCES ON PERFORMANCE IN 2013–14

Key Linkage Program developments during 2013–14 included:
- the announcement of a new cohort of ARC Centres of Excellence for funding commencing in 2014
- the announcement of a number of new initiatives aimed in building research capability in areas of Government priority
- continued demand for support under the Industrial Transformation Research Program.
## SUMMARY OF PERFORMANCE

2013–14 performance is summarised in Table 5.1.

### TABLE 5.1: LINKAGE PROGRAM, PERFORMANCE SUMMARY

<table>
<thead>
<tr>
<th>Deliverables</th>
<th>PERFORMANCE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of grants awarded</td>
<td>402</td>
<td>65</td>
</tr>
<tr>
<td>Number of researchers supported (investigators named in funded proposals)</td>
<td>1874</td>
<td>66</td>
</tr>
<tr>
<td>Amounts awarded to administering organisations</td>
<td>$546,911,900</td>
<td>66</td>
</tr>
<tr>
<td>Policy advice relating to encouraging research collaboration</td>
<td>Achieved</td>
<td>66</td>
</tr>
</tbody>
</table>

### Key performance indicators

- There is a high level of collaboration between ARC-supported researchers and those within other components of the national and international innovation systems: 4/4 targets met
- Outputs and outcomes arising from ARC-supported research are of a high quality and produce national benefits: 2/2 targets met
- ARC-supported research contributes significantly to high quality research training: 2/2 targets met
- ARC-supported research makes a significant contribution to research activity and capability in areas of national need: 2/2 targets met
DELIVERABLES

Through the Linkage Program schemes, the ARC delivers funding for individual research projects, hubs and centres. Funding is awarded to administering organisations on the basis of competitive peer review processes involving Australian and international experts.

### TABLE 5.2: LINKAGE PROGRAM, DELIVERABLES

<table>
<thead>
<tr>
<th>DELIVERABLE</th>
<th>RESULT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of grants awarded</td>
<td>2013–14: 402</td>
</tr>
<tr>
<td></td>
<td>2012–13: 267</td>
</tr>
<tr>
<td></td>
<td>2011–12: 454</td>
</tr>
<tr>
<td>Number of researchers supported (investigators named in funded proposals)</td>
<td>2013–14: 1874</td>
</tr>
<tr>
<td></td>
<td>2012–13: 1650</td>
</tr>
<tr>
<td></td>
<td>2011–12: 2098</td>
</tr>
<tr>
<td>Amounts awarded to administering organisations</td>
<td>2013–14: $546 911 900</td>
</tr>
<tr>
<td></td>
<td>2012–13: $130 428 000</td>
</tr>
<tr>
<td></td>
<td>2011–12: $194 483 000</td>
</tr>
<tr>
<td>Policy advice relating to encouraging research collaboration</td>
<td>2013–14: Achieved</td>
</tr>
<tr>
<td></td>
<td>2012–13: Achieved</td>
</tr>
<tr>
<td></td>
<td>2011–12: Achieved</td>
</tr>
</tbody>
</table>

### NUMBER OF GRANTS AWARDED

The ARC awarded 402 grants for funding commencing in 2013–14 under the Linkage Program:
- 12 ARC Centres of Excellence
- 10 Industrial Transformation Research Hubs
- 7 Industrial Transformation Training Centres
- 63 Linkage Infrastructure, Equipment and Facilities projects
- 2 Linkage Learned Academies Special Projects
- 306 Linkage Projects
- 2 Special Research Initiatives.

The significant increase in the number of grants awarded in 2013–14, compared to the 2012–13 (see also Figure 5.1), can be attributed to the following:
- In 2012 the ARC restructured the Linkage Projects scheme to complement the introduction of the Industrial Transformation Research Program—which supports fewer grants of a larger scale. All three schemes were conducted in full for the first time in 2013–14.
- A selection round under the ARC Centres of Excellence scheme was conducted for funding commencing in 2014. New grants have not been awarded under this scheme since 2010–11, as selection rounds are only conducted periodically.

Details of Linkage Program grants awarded for funding commencing in 2013–14 are provided on the ARC website.
NUMBER OF RESEARCHERS SUPPORTED

The 402 new grants awarded for funding commencing in 2013–14 under the Linkage Program involved 1874 researchers. Researchers, in this instance, are defined as named participants on successful funding proposals, that is chief investigators and partner investigators under the Linkage Projects; Linkage Infrastructure, Equipment and Facilities; Industrial Transformation Research Hubs; Industrial Transformation Training Centres; ARC Centres of Excellence; Linkage Learned Academies Special Projects; and Special Research Initiatives schemes.

The total number of researchers supported on new projects in 2013–14 is higher than the number recorded in 2012–13 due to the 2014 round of ARC Centres of Excellence (as indicated on page 65, this scheme is only run periodically). There was also a significant drop in 2012–13 as it was a transition year for the Linkage Projects scheme (reducing from two selection rounds to one selection round each year).

AMOUNTS AWARDED TO ADMINISTERING ORGANISATIONS

The ARC awarded $546.9 million in total funding for 402 new grants in 2013–14 under the Linkage Program schemes. The funding awarded comprised:

- $285.0 million over five years for the ARC Centres of Excellence scheme
- $34.6 million over five years for the Industrial Transformation Research Hubs scheme
- $15.7 million over three years for the Industrial Transformation Training Centres scheme
- $32.0 million for the Linkage Infrastructure, Equipment and Facilities scheme (predominantly one year grants)
- $0.8 million for over three years for the Linkage Learned Academies Special Projects scheme
- $101.8 million over three years for the Linkage Projects scheme
- $77.0 million over four and five years for the Special Research Initiatives scheme.

The total funding fluctuates each year depending on the selection rounds conducted. The increase in total funding awarded in 2013–14 is due to:

- the ARC Centres of Excellence selection round which is conducted periodically
- the conduct of a full selection round of the Linkage Projects scheme. The funding awarded in 2012–13 only included Linkage Projects for funding commencing in 2012 round 2.

POLICY ADVICE

In 2013–14 the ARC provided advice and engaged in discussion on a range of policy matters relevant to the Linkage Program. Policy issues relevant to both the Linkage and Discovery Programs are included in the case studies in Chapter 3, pages 41–45.
Schemes: Centres (ARC Centres of Excellence); ITRP (Industrial Transformation Research Program (which includes Industrial Transformation Research Hubs and Industrial Transformation Training Centres)); LASP (Linkage Learned Academies Special Projects); LIEF (Linkage Infrastructure, Equipment and Facilities); LP (Linkage Projects); SRIs (Special Research Initiatives)
OBJECTIVE—TO SUPPORT COLLABORATION IN AUSTRALIA AND INTERNATIONALLY

DESCRIPTION
The Linkage Program aims to improve research outcomes and the use of those outcomes by other sectors within the Australian economy and abroad by fostering long-term strategic alliances between higher education organisations and a range of end-user organisations, including industry, government and those in the community sector. The Program facilitates the development of alliances through:
- requirements for involvement of partner organisations making cash and in-kind contribution
- eligibility of partner organisations extended to overseas organisations.

PERFORMANCE
Key Performance Indicator 1: There is a high level of collaboration between ARC-supported researchers and those within other components of the national and international innovation systems (KPI 2.1 in ARC strategic plan)

<table>
<thead>
<tr>
<th>MEASURE 1</th>
<th>FINANCIAL COMMITMENT (CASH AND IN-KIND) FROM PARTNER ORGANISATIONS FOR EVERY DOLLAR CONTRIBUTED BY THE ARC (LINKAGE PROJECTS AND INDUSTRIAL TRANSFORMATION RESEARCH HUBS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target</td>
<td>Linkage Projects (LP): Greater than $1.90 Industrial Transformation Research Hubs (IH): Greater than $1.50</td>
</tr>
<tr>
<td>Result</td>
<td>2013–14: LP: $1.90 IH: $1.61 TARGET MET</td>
</tr>
<tr>
<td></td>
<td>2012–13: LP: $1.87</td>
</tr>
<tr>
<td></td>
<td>2011–12: LP: $2.05</td>
</tr>
</tbody>
</table>

The Linkage Projects scheme and Industrial Transformation Research Hubs both require universities and partnering organisations to make a financial commitment to the project equal to or greater than the amount of funding requested from the ARC. Both schemes achieved their targets for average financial commitment per dollar contributed by the ARC in 2013–14.

Under the Linkage Projects scheme the ARC awarded $101.8 million in funding to 306 new research projects involving collaborations with federal, state and local government agencies (26.1 per cent of funding awarded), industry bodies and companies (57.9 per cent of funding awarded), and community and not-for-profit agencies (10.5 per cent of funding awarded). Just over five per cent of ARC funding was awarded to projects collaborating with international government, universities and other sectors. Financial contributions from partner organisations to the 306 projects funded under the Linkage Projects scheme for funding commencing in 2013 are depicted in Figure 5.3.
FIGURE 5.3: LINKAGE PROJECTS SCHEME, PARTNER ORGANISATION CONTRIBUTIONS BY TYPE OF ORGANISATION, 2013–14

Measures:

**Measure 2**
Proportion of partner organisations that indicate that their involvement in projects was beneficial or very beneficial (Linkage Projects Scheme)

<table>
<thead>
<tr>
<th>Target</th>
<th>Greater than 90 per cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Result</td>
<td></td>
</tr>
<tr>
<td>2013–14</td>
<td>98.1 per cent (based on 2009 projects)</td>
</tr>
<tr>
<td>2012–13</td>
<td>94.8 per cent (based on 2008 projects)</td>
</tr>
<tr>
<td>2011–12</td>
<td>96.4 per cent (based on 2007 projects)</td>
</tr>
</tbody>
</table>

Under the Linkage Projects scheme, 98.1 per cent of partner organisations involved in grants commencing in 2009 indicated that their involvement in the research project was beneficial or very beneficial. This information is drawn from final reports submitted by applicants following completion of the research projects.
MEASURE 3 PROPORTION OF PROJECTS INVOLVING INTERNATIONAL COLLABORATION

<table>
<thead>
<tr>
<th>Target</th>
<th>Greater than 42 per cent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Result</td>
<td></td>
</tr>
<tr>
<td>2013–14:</td>
<td>45.5 per cent</td>
</tr>
<tr>
<td>2012–13:</td>
<td>44.6 per cent</td>
</tr>
<tr>
<td>2011–12:</td>
<td>40.7 per cent (LP and LIEF only)</td>
</tr>
</tbody>
</table>

A total of 45.5 per cent of new projects funded under the Linkage Program in 2013–14 involved international collaboration. This figure is marginally higher than last year due to the inclusion of the 2014 Centres of Excellence. The proportion of Centres of Excellence involving international collaboration is usually higher than other schemes funded under the Linkage Program. This is reflected in the fact that all of the newly funded Centres of Excellence involve international collaboration. There were 431 instances of intended international collaboration reported on the 402 successful proposals funded under the Linkage Program in 2013–14.

In addition, the ARC provided $3.6 million to support Australian membership of the International Ocean Discovery Program (IODP) over the next two years. The IODP is the largest collaborative research program in earth and ocean sciences and aims to address fundamental questions about Earth’s history and processes. Other major international collaborative projects the ARC continued to fund in 2013–14 were Australian membership of the Atomic Clock Ensemble in Space mission and access for Australian researchers to the NANTEN2 sub-millimetre telescope facility in Chile.

MEASURE 4 AVERAGE NUMBER OF ORGANISATIONS INVOLVED IN PROJECTS FUNDED (LINKAGE INFRASTRUCTURE, EQUIPMENT AND FACILITIES)

<table>
<thead>
<tr>
<th>Target</th>
<th>Greater than 3.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Result</td>
<td></td>
</tr>
<tr>
<td>2013–14:</td>
<td>5.2</td>
</tr>
<tr>
<td>2012–13:</td>
<td>4.3</td>
</tr>
<tr>
<td>2011–12:</td>
<td>3.9</td>
</tr>
</tbody>
</table>

The ARC awarded $32.0 million to 63 new research infrastructure, facilities and equipment projects in 2013–14. Over 90 per cent of these projects involved collaborations between Australian universities.

Linkage Infrastructure, Equipment and Facilities projects funded in 2013–14 involved an average of 5.2 collaborating organisations per project, almost one and half times the target. The increase in collaboration recorded since 2011–12 suggest that it is becoming more common for organisations to pool their resources to purchase important research infrastructure, equipment and facilities.
OBJECTIVE—TO SUPPORT EXCELLENT RESEARCH

DESCRIPTION
Through the Linkage Program, the ARC aims to support Australia’s highest quality research conducted in higher education institutions and other eligible organisations in partnership with end-user organisations. To ensure excellent research is funded, the ARC uses a rigorous assessment process involving academic peer review.

In 2013–14 the ARC amended the application form asking researchers to provide a statement indicating the contribution that their research could make to the Australian economy, society, culture, national security, public policy or services, health, the environment, or quality of life to better convey the benefits of publicly funded research.

PERFORMANCE

Key Performance Indicator 2: Outputs and outcomes arising from ARC-supported research are of a high quality and produce national benefits (KPI 2.2 in ARC strategic plan)

<table>
<thead>
<tr>
<th>MEASURE 5</th>
<th>EVIDENCE OF IMPACT ARC-FUNDED RESEARCH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target</td>
<td>Significantly exceeds benchmarks where available</td>
</tr>
<tr>
<td>Result</td>
<td>2013–14: Met</td>
</tr>
<tr>
<td></td>
<td>2012–13: Not measured</td>
</tr>
<tr>
<td></td>
<td>2011–12: Not measured</td>
</tr>
</tbody>
</table>

Information on assessment of this measure is provided under the similar measure for the Discovery Program (page 52). During 2013–14 the ARC continued to collect information on the outputs of ARC-funded research projects from final reports submitted to the agency. Under the Linkage Program, projects initially funded in 2009 produced an average of 10.1 academic outputs per research project, and a total of 40 commercialisation outputs. In 2013, ARC Centres of Excellence (initially funded in 2005, 2007 and 2011) produced an average of 249.8 academic outputs and a total of 45 patent-related outputs.

<table>
<thead>
<tr>
<th>MEASURE 6</th>
<th>OUTCOMES ARISING FROM ARC-FUNDED RESEARCH THAT PROVIDE SOCIAL, ECONOMIC, ENVIRONMENTAL AND CULTURAL BENEFITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target</td>
<td>Evidence of benefits arising from the outcomes of ARC-funded research</td>
</tr>
<tr>
<td>Result</td>
<td>2013–14: Met</td>
</tr>
<tr>
<td></td>
<td>2012–13: Met</td>
</tr>
<tr>
<td></td>
<td>2011–12: Met</td>
</tr>
</tbody>
</table>

The research case studies in Chapter 3 provide examples of the diverse outcomes produced by ARC-funded research in 2013–14. The case studies document the social, economic, environmental and cultural benefits generated by ARC-funded research.
OBJECTIVE—TO SUPPORT RESEARCH TRAINING AND CAREER DEVELOPMENT

DESCRIPTION
The ARC supports research training and career opportunities through stipends and project funds. ARC Centres of Excellence and Linkage Projects schemes allow eligible researchers and research teams to apply for project support for themselves, research assistants, research technicians and postgraduate students (further details on personnel supported under the Linkage Program can be found in Part 5, Appendix 2). Postgraduate and postdoctoral stipends are awarded under the Industrial Transformation Research Hubs and Centres schemes.

PERFORMANCE

Key Performance Indicator 3: ARC-supported research contributes significantly to high quality research training (KPI 2.3 in ARC strategic plan)*

<table>
<thead>
<tr>
<th>MEASURE 7</th>
<th>PROPORTION OF ARC-FUNDED RESEARCHERS WHO ARE EARLY CAREER RESEARCHERS (WITHIN FIVE YEARS OF COMPLETION OF THEIR PHD) (LINKAGE PROJECTS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target</td>
<td>Greater than 12 per cent</td>
</tr>
<tr>
<td>Result</td>
<td>2013–14: 12.7 per cent</td>
</tr>
<tr>
<td></td>
<td>2012–13: 13.2 per cent</td>
</tr>
<tr>
<td></td>
<td>2011–12: 14.2 per cent</td>
</tr>
<tr>
<td></td>
<td>Target Met</td>
</tr>
</tbody>
</table>

* See Appendix 9—Correction of Errors regarding discrepancies between these statistics and those reported in previous Annual Reports.

In 2013–14, 12.7 per cent of researchers named on successful proposals under the Linkage Projects scheme were early career researchers. While this appears to indicate that the number of early career researchers supported by the scheme is trending downwards, this is not believed to be the case because the number of early career researchers supported under the Linkage Projects scheme as reported at the end of the project (see Part 5, Appendix 2, Table A2.5) has been increasing over the last four years. It seems that early career researchers are being supported by the Linkage Projects scheme, but they are not being named in the original funding proposals. The ARC is considering new methods for measuring this KPI.

Data on the proportion of early career researchers supported under other Linkage Program schemes is not reported here as the postgraduates, postdoctoral and other early career researchers are not named in the application, but are recruited once the project is successful.

Further information on the number of early career researchers supported by the Centres of Excellence can be found in Part 5, Appendix 2, Table A2.4.
In 2013–14 the ARC funded seven new Industrial Transformation Training Centres. The new training centres will support 73 higher degree by research candidates and 20 postdoctoral fellows in research projects in eight industrial priority areas: defence manufacturing, manufacturing techniques, product design and development, product opportunities, food manufacturing capabilities, food processing, future food storage and other food-related research. More information on the training centres is provided on pages 77–78.

* Not measured in 2011–12 as the Industrial Transformation Training Centres scheme was first conducted in 2013.
OBJECTIVE—TO SUPPORT RESEARCH IN PRIORITY AREAS

DESCRIPTION

Under the Linkage Program researchers are invited to indicate whether their research addresses an area of Government priority. Proposals submitted under the Industrial Transformation Research Program must also address one of the Industrial Transformation Priorities identified for each funding round. In addition, the ARC provides scope for particular priorities or projects of national importance through Special Research Initiatives and the Linkage Learned Academies Special Projects scheme.

In 2013–14:
– as noted on page 56, the Australian Government identified new Strategic Research Priorities (SRPs) for government-funded research (replacing previous National Research Priorities),
– priorities were announced for the Industrial Transformation Research Program: manufacturing, food and agriculture, oil and gas, including petroleum, mining and mining services, and medical devices and biotechnology.

PERFORMANCE

Key Performance Indicator 4: ARC-supported research makes a significant contribution to research activity and capability in areas of national need (KPI 2.4 in ARC strategic plan)

<table>
<thead>
<tr>
<th>MEASURE 9</th>
<th>PROPORTION OF FUNDED PROPOSALS THAT ADDRESS THE NATIONAL RESEARCH PRIORITIES (NRPs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target</td>
<td>Greater than 90 per cent</td>
</tr>
<tr>
<td>Result</td>
<td>2013–14: 97.8 per cent</td>
</tr>
<tr>
<td></td>
<td>2012–13: 98.1 per cent</td>
</tr>
<tr>
<td></td>
<td>2011–12: 97.1 per cent</td>
</tr>
<tr>
<td></td>
<td>TARGET MET</td>
</tr>
</tbody>
</table>

Almost 98 per cent of new proposals funded under the Linkage Program in 2013–14 indicated that their research was relevant to at least one of the Australian Government’s four national research priority areas. The proportion of funded proposals indicating that the research is relevant to at least one national research priority area has remained steady over the last four years.

Over 40 per cent of new projects funded in 2013–14 addressed the National Research Priority—frontier technologies for building and transforming Australian industries—including two-thirds of the new ARC Centres of Excellence. Approximately one fifth, one quarter and one tenth of new projects funded in 2013–14 respectively address the Environment, Health and Security National Research Priorities. Less than 2.5 per cent of projects did not address one of the National Research Priorities.
### MEASURE 10

<table>
<thead>
<tr>
<th>Target</th>
<th>Examples of impact in NRP areas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Result</td>
<td>2013–14: Met</td>
</tr>
<tr>
<td></td>
<td>2012–13: Met</td>
</tr>
<tr>
<td></td>
<td>2011–12: Met</td>
</tr>
</tbody>
</table>

Support provided by the ARC in past years has contributed to new knowledge and outcomes for the community in each of the four priority areas nominated by the government. Examples of these contributions are highlighted in the case studies in Chapter 3.
OBJECTIVE—TO SUPPORT LARGE-SCALE COLLABORATIVE INITIATIVES

DESCRIPTION
Under the Linkage Program, the ARC funds large scale collaborative research programs including centres, hubs and networks.

In 2013–14 the ARC finalised the outcomes of:
- the ARC Centres of Excellence selection round for funding commencing in 2013–14
- three selection rounds conducted under the Industrial Transformation Research Program
- funding under two new special research initiatives announced in the 2014–15 budget.

PERFORMANCE

New research projects commencing in 2013–14

ARC CENTRES OF EXCELLENCE
In 2013–14 the ARC completed a selection round for ARC Centres of Excellence for funding commencing in 2014. Through the ARC, the Australian Government awarded $285.0 million over seven years to 12 new ARC Centres of Excellence. The 12 Centres of Excellence will support at least 176 researchers across 18 Australian universities and will collaborate internationally as well as with local industry, government and community groups.

- ARC Centre of Excellence for Children and Families over the Life Course, The University of Queensland
- ARC Centre of Excellence in Convergent Bio-Nano Science and Technology, Monash University
- ARC Centre of Excellence for the Dynamics of Language, The Australian National University
- ARC Centre of Excellence for Electromaterials Science, University of Wollongong
- ARC Centre of Excellence for Integrated Coral Reef Studies, James Cook University
- ARC Centre of Excellence for Integrative Brain Function, Monash University
- ARC Centre of Excellence for Mathematical and Statistical Frontiers of Big Data, Big Models, New Insights, The University of Melbourne
- ARC Centre of Excellence for Nanoscale BioPhotonics, The University of Adelaide
- ARC Centre of Excellence in Plant Energy Biology, The University of Western Australia
- ARC Centre of Excellence for Robotic Vision, Queensland University of Technology
- ARC Centre of Excellence for Translational Photosynthesis, The Australian National University
INDUSTRIAL TRANSFORMATION RESEARCH PROGRAM

The first round under the Industrial Transformation Research Hubs scheme in 2013–14 funded three hubs in research areas that will advance Australia’s manufacturing industries. The second round funded seven new hubs to underpin Australia’s future in manufacturing, food and agriculture, oil and gas (including petroleum), mining and mining services, and medical devices and biotechnology. Together the ten hubs will support 117 researchers and involve collaborations between 16 Australian universities and 43 industry partner organisations. Total funding for the hubs from the ARC is $34.6 million over five years, with industry partners contributing a further $55.7 million in cash and in-kind financial support.

ROUND 1
- ARC Research Hub for Australian Steel Manufacturing, University of Wollongong
- ARC Research Hub for Bioprocessing Advanced Manufacturing, Monash University
- ARC Research Hub for Transforming Australia’s Manufacturing Industry through High Value Additive Manufacturing, Monash University

ROUND 2
- ARC Research Hub for Advanced Breeding to Transform Prawn Aquaculture, James Cook University
- ARC Research Hub for Advanced Technologies for Australian Iron Ore, The University of Newcastle
- ARC Research Hub for Australian Copper-Uranium, The University of Adelaide
- ARC Research Hub for Basin GEodyNamics and Evolution of Sedimentary Systems (GENESIS), The University of Sydney
- ARC Research Hub for Genetic Diversity and Molecular Breeding for Wheat in a Hot and Dry Climate, The University of Adelaide
- ARC Research Hub for Transforming the Mining Value Chain, University of Tasmania
- ARC Research Hub for Transforming Waste Directly in Cost-Effective Green Manufacturing, The University of New South Wales

The 2014 round of Industrial Transformation Training Centres awarded $15.7 million over three years to seven training centres that will address research areas vital to the future of Australia’s food and manufacturing industries. The centres will also encourage close partnerships between university researchers and industry, with eight Australian universities collaborating with over 40 industry partner organisations.
- ARC Training Centre for the Australian Food Processing Industry in the 21st Century; The University of Sydney
- ARC Training Centre in Biodevices; Swinburne University of Technology
- ARC Training Centre for Food and Beverage Supply Chain Optimisation; The University of Newcastle
- ARC Training Centre for Functional Grains; Charles Sturt University
- ARC Training Centre for Innovative Horticultural Products; University of Tasmania
- ARC Training Centre for Portable Analytical Separation Technologies; University of Tasmania
- ARC Training Centre for Transforming Australia’s Naval Manufacturing Industry; University of Tasmania

**SPECIAL RESEARCH INITIATIVES**

Two new initiatives were funded under the Special Research Initiative scheme—the Special Research Initiative for Tropical Health and Medicine and the Special Research Initiative for Type 1 Juvenile Diabetes.

The **Special Research Initiative for Tropical Health and Medicine** provided $42 million of funding over four years to build Australia’s research capacity in tropical health and biomedical sciences. The initiative represents the Government’s electoral commitment for ‘Boosting Front Line Healthcare and Research’ by funding the Institute of Tropical Health and Medicine at James Cook University. The successful Initiative, led by the Administering Organisation and involving researchers with track records in quality research outcomes and coordinating team-based cross-disciplinary projects, will ensure that our citizens have the best possible treatments for tropical health matters.

The **Special Research Initiative for Type 1 Juvenile Diabetes** provided $35 million for the creation of national collaborative research network to with a core function of significant progress towards finding a cure for Type 1 Juvenile Diabetes. The Program will be a national collaborative network, led by the Administering Organisation, the Juvenile Diabetes Research Foundation (JDRF) and involve researchers with track records in quality research outcomes and coordinating team-based cross-disciplinary projects. The network’s core function will include significant progress towards finding a cure for Type 1 Juvenile Diabetes, which affects many Australian children.
Research projects receiving ongoing funding in 2013–14

SPECIAL RESEARCH INITIATIVES SCHEME

In 2010 the ARC awarded $50 million to two Australian research teams to develop a bionic eye under the ARC’s Research in Bionic Vision Science and Technology Initiative. Following an independent review in 2013 that found both research teams had made exceptional advances, the ARC awarded an additional $10 million to the research teams to continue their ground-breaking work into 2014. The two teams are working on different methods to develop bionic vision, each focusing on a different type of blindness. The Monash Vision Group is developing a device to implant on the visual cortex of the brain, providing treatment for progressive blindness. Bionic Vision Australia is developing technology that implants a device in the rear of the eye to enable vision to blind patients suffering from degenerative retinal conditions.

Stem Cells Australia was awarded $21 million over seven years in July 2011 to build Australia’s capacity to conduct stem cell research. In 2013–14 Stem Cells Australia made technological advances producing new insights into bone repair and remodelling. They also continued to be involved in international collaborations using stem cells to create new ways to understand diseases and test new drugs.

The ARC awarded $25 million under the Special Research Initiative in Synchrotron Science in 2012 to support access to the Australian Synchrotron over four years. The Australian Synchrotron is the largest stand-alone piece of scientific infrastructure in the southern hemisphere and can be used by almost any industry across a wide-range of research fields to study the most precise nature of any biological or industrial material. Research highlights in 2013–14 include contributing to the research that led to the 2013 Nobel Prize for Physics being awarded for the theoretical predication of the Higgs boson, and a young synchrotron researcher developing the first 4D lung x-ray. Case studies highlighting Australian Synchrotron research can be found in Chapter 3, pages 23 and 36.

The National Indigenous Research and Knowledges Network (NIRAKN) was awarded $3.2 million over four years under the Special Research Initiative for an Aboriginal and Torres Strait Islander Researchers’ Network in 2012. The Network brings together 44 Aboriginal and Torres Strait Islander researchers from 21 Australian universities and across many research disciplines to facilitate collaborative and innovative approaches to research and research training, and to build the capacity of Indigenous Australian researchers to undertake and lead high quality research at all career stages. Further information on the activities of NIRAKN in 2013–14 can be found in the case study on page 30.

In May 2013 the ARC awarded $16 million over four years to establish a new Science of Learning Research Centre at the University of Queensland and involving six other Australian universities, nine partner organisations and the Australian Council for Educational Research. Further information on the activities of Science of Learning Research Centre in 2013–14 can be found in the case study on page 30.
CO-FUNDED RESEARCH CENTRES

The ARC and the Grains Research and Development Corporation jointly committed $47.8 million to fund the Australian Centre for Plant Functional Genomics (ACPFG) from 2002 until the end of 2014. ACPFG has four nodes located around Australia at The University of Adelaide, The University of Melbourne, The University of Queensland and the University of South Australia. In 2013–14 researchers at the centre continued to investigate and develop techniques to improve the resistance of wheat, barley and other crops to hostile environmental conditions such as drought, salinity and mineral deficiencies or toxicities. The centre also announced their involvement in a number of international projects to assist global food security, health and production including:

- the European EURoot research project which aims to enhance the performance of cereal plants under stress conditions
- a partnership with the United States Agency for International Development and India-based Vibha Agrotech to develop new climate-resilient varieties of rice and wheat
- a project with World Vision Australia and the International Food Policy Research Institute to produce high value and micronutrient-enriched rice grain.

The National Centre for Groundwater Research and Training (NCGRT) was established in June 2009 as a joint funding initiative between the ARC and the National Water Commission (NWC). The ARC and the NWC committed up to $29.5 million to the centre over five years. In 2013–14 the centre contributed to the development of Australia’s new National Groundwater Strategy and released a report on the economic value of groundwater in Australia. International collaboration activities undertaken by the centre in 2013–14 included:

- hosting a number of international meetings and conferences, including the International Association of Hydrogeologists Congress in Perth and the 20th International Congress on Modelling and Simulation in Adelaide
- contributing to the UNESCO-led discussions on a Global Framework for Action to protect the Earth’s imperilled groundwater resources
- cementing a partnership with the Australian Water Association and the US National Ground Water Association to deliver training and courses in conjunction.

National ICT Australia (NICTA) is jointly funded by the ARC and the Department of Communications, providing a total of $606.5 million in funding over 15 years (2002–16). NICTA was established in 2002 to build capacity and strengthen investment in strategic information and communications technology research in Australia and is currently Australia’s largest organisation dedicated to ICT research. In 2013–14 NICTA researchers developed a new approach to optimising bus operations in Canberra, reducing travel times by one third and costing less than the current system, and developed the first truly scalable and accurate evacuation planning and scheduling system. A number of NICTA researchers also won awards for their research.
Industrial Transformation Research Hubs support Australia’s best researchers to engage in cutting edge research on new technologies and economic and social transformation. The scheme supports collaborative research initiatives between the Australian higher education sector and industry to achieve strategic outcomes. The ten hubs funded in 2013–14 addressed research in the areas of manufacturing, food and agriculture, oil and gas (including petroleum), mining and mining services, and medical devices and biotechnology. Two hubs are highlighted below.

**ARC Research Hub for Advanced Technologies for Australian Iron Ore**

The ARC Research Hub for Advanced Technologies for Australian Iron Ore will be based at The University of Newcastle and will bring together three areas of research strength at the University—beneficiation, raw materials handling and iron ore utilisation. The collaboration aims to address the complex issues that arise from different iron ore types that have emerged in recent years and, if successful, the outcomes should benefit the entire industry.

The Hub will engage with mining organisations, companies and equipment manufacturers with the aim of establishing new Australian iron ore separation and handling techniques and supporting the use of Australian ores.

**ARC Research Hub for Genetic Diversity and Molecular Breeding for Wheat in a Hot and Dry Climate**

Wheat production is worth over $5 billion annually to the Australian economy and wheat is one of the most important sources of protein and carbohydrate in the human diet. The Hub, which will be established at The University of Adelaide, will bring together the Australian Centre for Plant Functional Genomics (ACPFG) and the Grains Research and Development Corporation as well as wheat breeding companies to deliver advanced technologies, breeding material and information to produce new varieties of wheat that are tolerant to stressful environments.

Hub Director, Associate Professor Sigrid Heuer says the Hub has been awarded at an ideal time to take advantage of a decade of work by ACPFG. ‘This is really wrapping up many years of research and trying to put it into practice now. A lot of work went into developing heat and drought tolerance, and we feel we have a lot to pass on to the breeders already.’
Photo: The Executive members of the ARC Centre of Excellence for Children and Families over the Life Course, July 2014: (L to R) Professor Janeen Baxter, Professor Mark Western, Professor Deborah Cobb-Clark and Professor Stephen Zubrick.

Photo: Professor Kevin Galvin, Director of the Hub for Advanced Technologies for Australian Iron Ore with a Reflux Gravitron for beneficiating fine particles.
ARC Centre of Excellence for Children and Families over the Life Course

Family background plays a central role in determining the adult outcomes of young people in Australia. Social disadvantage concentrates in low income communities and specific subgroups of the population, and is highly likely to reproduce in families across generations. The growing divide between high and low income earners has become a crucial factor determining life chances, and is one of the top risks facing Australia over the next few decades, as social disadvantage has far-reaching human, social and economic costs.

It is in this context that the new ARC Centre of Excellence for Children and Families over the Life Course (Life Course Centre) has emerged. Centre Director Professor Janeen Baxter states ‘It is essential that we understand how such disadvantage is produced and reproduced in contemporary Australia. The Life Course Centre aims to further existing knowledge about the mechanisms driving social disadvantage in Australia and gather necessary research evidence to guide and inform future policies aimed at preventing its emergence and transmission.’

ARC Centre of Excellence for Robotic Vision

Robots cannot currently understand their environment using the sense of vision and it is this missing capability that currently prevents robots from performing useful tasks in the complex, unstructured and dynamically changing environments in which we live and work. The ARC Centre of Excellence for Robotic Vision will deliver the breakthrough science and technologies to create a new generation of robots that can visually sense and understand complex and unstructured real-world environments. Robotic automation has transformed manufacturing, household cleaning and will soon transform the car. The work of this Centre will increase the application of technology in agriculture, smart manufacturing, construction and remote inspection and monitoring.

Professor Peter Corke, the Centre Director explains, ‘The technology to build the mechanical vehicles and robotic devices for these applications is available. The remaining technological roadblock is the ability to perceive and thereby adapt to the environment, and to seamlessly integrate perception with action.’
Stephanie Villeneuve, a research associate at the National Centre for Groundwater Research and Training, is measuring water quality.
Excellence in Research for Australia (ERA) evaluates the quality of the research conducted at Australian universities in all research disciplines (including medical and health sciences).

ERA aims to improve research outcomes by identifying universities and disciplines that are internationally competitive and highlighting areas where there are opportunities for further development and investment. Specifically, ERA aims to:

– administer an evaluation framework that gives Government, industry, business and the wider community assurance of the excellence of research conducted in Australia’s higher education institutions
– provide a national overview of areas of research strength and areas where there may be opportunity for development
– allow for comparisons of Australia’s research nationally and internationally for all disciplines offered in Australian higher education institutions
– allow for comparisons of Australia’s research effort over time.

ERA is an ongoing Australian Government program. The ARC conducted a trial in 2009 and has now completed two full rounds of evaluation in 2010 and 2012. In December 2012, the previous government announced a further round of ERA would be conducted in 2015.

INFLUENCES ON PERFORMANCE IN 2013–14

Key ERA Program developments during 2013–14 included:

– the ongoing program of consultation with relevant stakeholders, primarily universities
– the continued focus on improving ERA processes for ERA 2015.
SUMMARY OF PERFORMANCE
2013–14 performance is summarised in Table 6.1.

TABLE 6.1: EXCELLENCE IN RESEARCH FOR AUSTRALIA, PERFORMANCE SUMMARY

<table>
<thead>
<tr>
<th>Deliverables</th>
<th>PERFORMANCE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preparation for the ERA 2015 evaluation</td>
<td>Achieved</td>
<td>87</td>
</tr>
<tr>
<td>Provide ongoing policy advice on broader research matters related to the measurement of research quality</td>
<td>Achieved</td>
<td>87</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Key performance indicators</th>
<th>PERFORMANCE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contribution to best practice evaluation of Australia’s research investment in universities</td>
<td>Target met</td>
<td>89</td>
</tr>
<tr>
<td>ERA results continue to inform other higher education research policy initiatives</td>
<td>Target met</td>
<td>90</td>
</tr>
<tr>
<td>Universities continue to engage with the ARC about changes to ERA for the next evaluation</td>
<td>Target met</td>
<td>90</td>
</tr>
</tbody>
</table>
DELIVERABLES

Through ERA the ARC delivers a national evaluation of the quality of research undertaken in Australia’s universities. As ERA evaluations are conducted periodically, deliverables are specific to each year. The 2013–14 deliverables reflect the preparatory phase for the 2015 round of ERA.

TABLE 6.2: EXCELLENCE IN RESEARCH FOR AUSTRALIA, DELIVERABLES

<table>
<thead>
<tr>
<th>DELIVERABLE</th>
<th>RESULT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preparation for the ERA 2015 evaluation</td>
<td>Preparations for ERA 2015 are well advanced and key milestones have been met.</td>
</tr>
<tr>
<td>Provide ongoing policy advice on broader research matters related to the</td>
<td>The ARC has provided ongoing policy advice to a range of government stakeholders on issues related to the ERA process and outcomes.</td>
</tr>
<tr>
<td>measurement of research quality</td>
<td></td>
</tr>
</tbody>
</table>

PREPARATION FOR THE ERA 2015 EVALUATION

In 2013–14 the ARC undertook an extensive review of ERA 2012 and consulted with the university sector to prepare for ERA 2015. Two major public consultations were undertaken in 2013–14 on the:

- draft ERA 2015 Submission Documentation, including an outline of key proposed changes for ERA 2015.
- draft ERA 2015 Journal and Conference Lists, defining which outlets are scholarly, peer reviewed, publish original research and are eligible for ERA 2015 submissions.

No ERA Research Evaluation Committees were convened in 2013–14, but preparations for the recruitment of committee members for ERA 2015 commenced.

POLICY ADVICE

During 2013–14 the ARC used ERA information to provide ongoing policy advice to government, including to the Department of Education, the Department of Industry, the Chief Scientist and other government stakeholders.

The results from ERA 2010 and ERA 2012 provide detailed information about the research landscape in the Australian university sector. Data on research outputs (including books, journal articles, conference papers and other non-traditional research outputs) submitted for ERA cover a six year reference period.
OBJECTIVE—TO IMPROVE RESEARCH OUTCOMES BY IDENTIFYING UNIVERSITIES AND DISCIPLINES THAT ARE INTERNATIONALLY COMPETITIVE

DESCRIPTION

ERA collects a wide variety of indicators for evaluating research quality, research application and esteem measures. Outcomes of each ERA round are published in a national report. In addition to the national report, the ARC uses data collected through ERA to analyse research activity relating to specific areas of research.

The evaluations are conducted by ERA Research Evaluation Committees. The committees comprise distinguished and internationally-recognised researchers with expertise in research evaluation. Their judgements are informed by a range of indicators as well as more traditional measures of quality, such as citation analysis and peer review.

Committees are responsible for determining the rating given for each discipline in Australia’s higher education institutions. Committees use the ERA information to determine ratings for a unit of evaluation (UoE). A UoE is a discipline area within a university.

The ERA rating scale is from 1 to 5, where:
- a rating of 1 is for research that is well below world standard
- a rating of 2 is for research that is below world standard
- a rating of 3 is for research that is at world standard
- a rating of 4 is for research that is above world standard
- a rating of 5 is for research that is well above world standard.

ERA methodology requires universities to submit comprehensive information about their research activities, including: information about staff; research publications; awards; grants; patents; and commercial income. Using the information provided, committees of internationally recognised experts make judgements about the quality of Australian research relative to world standards. Reports of previous ERA rounds have provided assurance about the quality of Australian university research against world benchmarks.
PERFORMANCE

Key Performance Indicator 1: Contribution to best practice evaluation of Australia’s research investment in universities (KPI 3.1 in ARC strategic plan)

<table>
<thead>
<tr>
<th>MEASURE 1</th>
<th>EVIDENCE OF CONTRIBUTION TO BEST PRACTICE EVALUATION OF RESEARCH INVESTMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target</td>
<td>Examples of contribution to best practice</td>
</tr>
<tr>
<td>Result</td>
<td>Achieved</td>
</tr>
<tr>
<td></td>
<td>TARGET MET</td>
</tr>
</tbody>
</table>

To ensure that ERA 2015 is conducted as a best practice evaluation of university research, during 2013–14 the ARC undertook extensive preparation and consultations with the sector.

The previous ERA rounds, conducted by the ARC in 2010 and 2012, used sophisticated methodology to determine ratings given to the Unit of Evaluation in each university. As outlined in the description, committees of internationally recognised experts used information derived from citation analysis or peer review to make their judgements. The robustness of the ERA methodology used in ERA 2010 and ERA 2012 has been recognised internationally. An Organisation for Economic Cooperation and Development (OECD) report noted that ERA’s use of expert review informed by metrics to evaluate quality and promote excellence in research was ‘state of the art’ (Performance-based Funding for Public Research in Tertiary Education Institutions, OECD 2010).

To prepare for ERA 2015, the ARC built on the methods used in ERA 2010 and ERA 2012. Preparations undertaken by the ARC in 2013–14 were aimed at ensuring the ERA framework continues to be consistently applied. For example, to allow for comparison of 2015 results to previous rounds, the ARC has ensured:

- the length of the reference periods applied to research outputs and other indicators will be consistent with ERA 2012 and ERA 2010
- key data and evaluation methodologies will be consistently applied across ERA rounds.

In addition, the ARC identified possible improvements following further internal analysis and sector consultation. Possible improvements canvased included:

- reintroducing conference list (no ranking)
- introducing a book publisher list (for data streamlining and collection only)
- including a new research output type: Research Report for an External Body
- requesting gender data (not for evaluation)
- Open access repository (not for evaluation)
- requiring that peer review research outputs must be in an ERA repository
- changing staff eligibility to 0.4 full-time equivalent (FTE) or less (publication association required)
- conducting a conference citation trial (for selected fields of research only)
- providing a peer review dashboard to participating organisations.
Key Performance Indicator 2: ERA results continue to inform other higher education research policy initiatives (KPI 3.2 in ARC strategic plan)

<table>
<thead>
<tr>
<th>MEASURE 2</th>
<th>EVIDENCE OF IMPACT OF POLICY ADVICE IN HIGHER EDUCATION INSTITUTIONS AND ACROSS GOVERNMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target</td>
<td>Examples of impact of policy advice and an improved capacity for the ARC to contribute to the national innovation agenda</td>
</tr>
<tr>
<td>Result</td>
<td>Achieved</td>
</tr>
</tbody>
</table>

In 2013–14 ERA information was used to provide advice to the government on a range of university research related issues and inform higher education research funding.

For example, ERA 2012 results were used by the Sustainable Research Excellence in Universities (SRE) scheme to moderate the SRE Threshold 2 funding to universities for 2014. The SRE scheme, administered by the Department of Education, provides block grants on a calendar year basis to eligible higher education providers to assist with the indirect cost of research activities. More information about the SRE scheme is available on the Department of Education website.

Key Performance Indicator 3: Universities continue to engage with the ARC about changes to ERA for the next evaluation (KPI 3.3 in ARC strategic plan)

<table>
<thead>
<tr>
<th>MEASURE 3</th>
<th>SECTOR CONSULTATION CONTRIBUTES TOWARDS FUTURE DEVELOPMENT OF ERA PROCESSES AND POLICY FOR ERA 2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target</td>
<td>Improved process and policy for ERA 2015</td>
</tr>
<tr>
<td>Result</td>
<td>Achieved</td>
</tr>
</tbody>
</table>

During 2013–14 the ARC received extensive input from stakeholders during public consultations on draft documentation for ERA 2015.

The ARC invited comment on the draft ERA 2015 Submission Documentation, which included an outline of key proposed changes for ERA 2015. The draft Submission Documentation underwent public consultation from 10 January to 14 February 2014. The ARC received 72 responses to the draft ERA 2015 Submission Documentation consultation. A range of stakeholders provided responses including: universities; peak bodies; discipline groups; other organisations and individuals. Of the 72 responses, 35 were from the universities who participate in ERA, representing the majority of the university sector (35 out of 41 ERA eligible institutions).
Between 3 February and 21 March 2014 the ARC invited comment on the Draft ERA 2015 Journal List and Conference List. The journal and conference lists form an integral part of the ERA submission process, defining outlets that are scholarly; peer-reviewed; publish original research; and which are eligible for ERA 2015 submissions. For the Draft ERA 2015 Journal List and the Draft ERA 2015 Conference List consultations, the ARC received: 6557 journal comments; 2896 new journal recommendations; 813 conference comments; and 1501 new conference series recommendations.

Additional consultation with university sector stakeholders was undertaken by the ARC to determine which journals and conferences met the eligibility criteria for inclusion in ERA 2015 lists.

Universities, individual academics, discipline groups and peak bodies provided a range of feedback and suggestions during the two consultations. More than 3000 users registered to provide feedback on the journal and conference lists.

The ARC’s strong commitment to consult with stakeholders to inform the ERA 2015 evaluation process constructively engaged stakeholders with proposed changes to submission requirements and resulted in the ARC receiving extensive and on-going input to the draft documentation.
Professor Peter Taylor (L) and Professor Lloyd Hollenberg (R), Australian Laureate Fellows at The University of Melbourne.

Photo courtesy of Peter Casamento.