# Research Engagement for Australia

Measuring research engagement between universities and end users

A report of a pilot study by the Australian Academy of Technology and Engineering (ATSE)

# Contents

# Executive Summary

The Australian Academy of Technology and Engineering (ATSE) advocates for a future in which technology, engineering and innovation contribute significantly to Australia's social, economic and environmental wellbeing. ATSE believes that realising the benefits of Australia's world-class research system requires translation of its outputs into economic and societal benefits. The effective translation of research will be at the core of Australia's future competitiveness and prosperity.

In mid-2014 a group of ATSE Fellows, concerned by the recently published data which showed that Australia was ranking bottom of the OECD when it came to collaboration between public and private sector researchers, set up a working party to develop a metric which would measure collaboration between university researchers, industry and other end users of their research. The group was alarmed by reports that the Excellence in Research Australia (ERA) exercise, while very desirable in its own right, was having the unintended effect of discouraging university-researcher collaboration with industry and other end users. The ATSE proposal was to use the income received from industry and other research end users to support research collaboration plus commercialisation income as the basis for an engagement metric. The proposal was welcomed in university, industry and government circles.

While there had been a number of previous proposals in Australia to use case studies as the basis on which research impact is measured, these proposals had not progressed because of the high cost associated with such exercises, difficulties around the attribution of impact, and the fact that such measures are a lagging indicator of university performance. Research engagement is a necessary condition for impact, and the ATSE engagement metric is a forward proxy for impact. The metric also aligns well with the measure used by the OECD.

From the outset, it was felt that it was very important that any metric developed had to be applicable and useful for the humanities, arts and social sciences (HASS) as well as science, technology, engineering and mathematics (STEM) fields. Accordingly, the steering committee membership for this project was expanded to include representatives of the four Learned Academies (Humanities, Social Sciences, Science, and Technology and Engineering), the Australian Research Council (ARC), senior researchers from the HASS, STEM and medical and health sciences (MHS) fields, and senior representatives of the key Commonwealth Departments (Education & Training and Industry, Innovation & Science). The Steering Committee met on two occasions face to face, three times by teleconference, and regularly electronically to comment on draft material. The project was named 'Research Engagement for Australia' (REA).

With the assistance of the Department of Education & Training (DET) and the ARC, it was shown that it is possible to develop engagement metrics from existing data collections, namely the data submitted by universities to the ARC as part of the ERA exercise, and the annual Higher Education Research Data Collection (HERDC) returns submitted to DET. The key and simplifying principle used in REA is to use external dollars attracted from industry and other end users to support research as a direct measure of research engagement. Comparisons between universities for the same research discipline were carried out by applying the metric at the two digit Field of Research (FoR) code level.

Using de-identified data provided by the ARC, it was possible to calculate the REA Metrics for the 22 FoR codes provided by 41 Universities in the 2012 ERA exercise. The results obtained for the REA metrics were different to those obtained for the ERA rating, showing that the engagement metrics were identifying collaborative activities in the university sector that are not distinguished by existing measures of research excellence (ERA). The results of this initial evaluation showed that areas assessed to have high end-user engagement scores predominantly had high ERA excellence scores, while areas with low ERA scores rarely had high engagement scores. Importantly, there were many cases of high ERA ratings without strong engagement. The bulk of the highest ranking areas for engagement scored ERA 4 and 5. In other words, research excellence is an important, but not sufficient, condition for collaboration and innovation.

## Impact proxy

In March 2015, a report on the development of the REA Metrics was prepared by the Steering Committee and submitted to the Department of Education and Training (the 'REA Proposal'). This report outlined how the REA Metrics provided a measure of research engagement and collaboration as a forward proxy of impact. The REA rating is intended to visibly stand alongside the existing ERA measurement of research excellence – bringing a second dimension to the assessment of Australia's research.

Subsequently, ATSE received funding from the South Australian and Queensland Governments to conduct a pilot study of the ATSE engagement metrics (REA) with the universities in the two States – a total of eleven universities. This pilot study is described in greater detail in the body of this report, essentially representing a *beta* test of the ATSE engagement metrics.

The REA Pilot has confirmed that REA is a cost-effective and robust measure of research engagement: universities were able participate in the data provisions with minimal resourcing burdens, making use of the existing systems in support of other internal and external reporting requirements such as ERA and HERDC. The results of the REA Pilot, provided to universities, provided an intuitive and believable method of measuring research engagement. Strong REA performance was related to ongoing research engagement activities within the university and broadly accorded with the expectations of the university in terms of their perceived areas of strong research engagement. In addition, the REA Pilot confirmed earlier findings that REA measures aspects of research activity that are not captured through existing measures, such as ERA.

The pilot study has developed a mechanism that allows the private sector contributions to Rural R&D Corporations funding to be estimated and included in the metric determination. Also, a number of universities in the cohort obtain income from extension activities based on research from the universities that is not counted in HERDC returns, and it was felt that these monies should form part of the REA Metrics calculations.

## Additional indicator

To assist in identifying the different types of activity underlying REA performance, an additional contextual indicator is proposed, namely the proportional contribution of research partner income and commercialisation income for each FoR return. In addition, it is proposed that universities be given the option to provide short vignettes explaining why a particularly strong REA result for the FoR was obtained, or why specific examples of engagement were not captured by the data reported. These vignettes would be published to provide context for the REA metrics data and to be used as exemplars by university and government of positive engagement.

The results of the pilot study, along with additional input from the original Steering Committee, have made it possible to further refine the REA Metrics. As a result of the pilot study, we are now confident that we can collect the income from 'industry and other end users of the research, and commercialisation income', which provide the numerator for the metrics. The denominators described in the March 2015 report as 'M2' (share of national

engagement) and 'M3' (research intensiveness) are to be used to determine a single 'REA Index' for the universities contributing to each two digit field of research (FoR). An expert panel can then assess the distribution of the REA Index for each FoR, and, informed by the context provided by the vignettes and the information from 'M1' (engagement per FTE), determine cut-offs for universities in that FoR to be awarded an 'A' (well above national average for engagement), 'B' (above national average for engagement), or 'C' (below national average for engagement).

The REA Index would be published and provided for each FoR to the relevant university, along withthe data for M1, which may be a useful management tool for universities, faculties and departments.

From our extensive consultation on the engagement metrics, ATSE is confident that the publication of the REA results will drive behaviour towards increased engagement. Given the result of the REA Pilot, it is feasible for the REA to be deployed as a priority. While ATSE had not in its reports linked REA results to funding, it is very supportive of recommendations 19 to 23 of the *Review of Research Policy and Funding Arrangements* delivered by Dr Ian Watt in November 2015. However, ATSE remains strongly of the view that, while there is very strong support for the proposed changes to the funding formulas for the Research Block Grant allocation, it needs to be remembered that such block grant allocation is based on a whole-of-university formula that is not particularly visible to those outside the higher levels of university management. The proposal to publish ratings for the ATSE Engagement Metric (REA) in each field of research alongside the corresponding ERA results will allow it to become a very visible indicator that will be an effective management tool and will be a key modifier of behaviour.

**From our extensive consultation on the engagement metrics, ATSE is confident that the publication of the REA results will drive behaviour towards increased engagement.**

# Introduction

The Australian Academy of Technology and Engineering (ATSE) advocates for a future in which technology, engineering and innovation contribute significantly to Australia's social, economic and environmental wellbeing. The Academy is empowered in its mission by some 800 Fellows drawn from industry, academia, research institutes and government, who represent the brightest and the best in technological sciences and engineering in Australia. ATSE provides robust, independent and trusted evidence-based advice on technological issues of national importance. ATSE fosters national and international collaboration and encourages technology transfer for economic, social and environmental benefit.

ATSE believes that realising the benefits of Australia's world-class research system requires translation of its research into economic and societal benefits. The effective translation of research will be at the core of Australia's future competitiveness, wellbeing and prosperity. Australia undertakes world-class scientific research through universities and other publicly funded research organisations, such as the Commonwealth Scientific and Industrial Research Organisation (CSIRO), the Australian Nuclear Science and Technology Organisation (ANSTO) and the Australian Institute of Marine Science (AIMS).

Two key aspects affecting Australia's ability to translate research into broad benefits for the nation are:

> Ensuring that research can be absorbed into existing industries and policy development by fostering high levels of engagement between Australia's university researchers and research end-users across the private, public and not-for-profit sectors; and

> Fostering an entrepreneurial university research culture capable of creating new and innovative industries from the research base to fuel economic development and provide growth of highly skilled jobs.

Supporting these two aspects will assist in ensuring that Australia's publicly funded university research can meet the needs of today's industries[1], as well as develop new, innovative industries into the future.

Throughout 2014 and 2015, ATSE has undertaken to explore options for developing metrics to measure Australian universities' research engagement with industry. This work is intended to ensure that research engagement between Australian universities and research end-users is appropriately recognised and rewarded alongside other measures of university activities such as research excellence. It is hoped that introducing research engagement metrics will help to increase the social and economic return on the public investment in research in Science, Technology, Engineering and Mathematical Sciences (STEM), Medical and Health Sciences (MHS) and Humanities, Arts and Social Sciences (HASS) alike.

## Background to Research Engagement for Australia

### Publicly funded research for social and economic change

The increasing importance of publicly funded research as an economic and social driver has been a common experience across OECD countries. For example, in the United States (US), the *America Competes Act (2007)* was designed to drive public investment 'in innovation through research and development, and to improve the competitiveness of the United States',[2] while recommendations to the US House of Representatives and the US Senate by the National Academies during the recent economic downturn identified public research investment as key to transforming and rebuilding the national economy.[3]

Across the OECD more broadly, significant changes have taken place in the shape and structure of national economies. The rise of creative-, technology- and service-based industries, and productivity gains realised on the back of innovations in farming, mining, advanced manufacturing and management processes have become important drivers of economic prosperity. Publicly funded research has been at the core of developing these innovative industries and driving productivity. The emerging role of university-based research is evident in the increased identification of applied research in Australian universities (see Appendix A for definitions of types of research activity). Since 1992, increases in Higher Education Expenditure on Research and Development (HERD) have been accompanied by increased university reporting of applied research activities to the Australian Bureau of Statistics (ABS). In this period, the shape of Australian higher education research activities has

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1     'Industries' is used throughout this report with reference to private-, public- and not-for-profit sectors.

2     United States Congress (2007), *America Competes Act*. http://www.govtrack.us/congress/bills/110/hr2272/text

3     Rising Above the Gathering Storm Committee (2010), *Rising Above the Gathering Storm, Revisited: Rapidly Approaching Category 5*. http://www.nap.edu/catalog/12999/rising-above-the-gathering-storm-revisited-rapidly-approaching-category-5

## Figure 1 Australian Higher Education Expenditure on R&D by Activity Type, 1992–2012[4]

HERD – Billions ($)

HERD by activity type
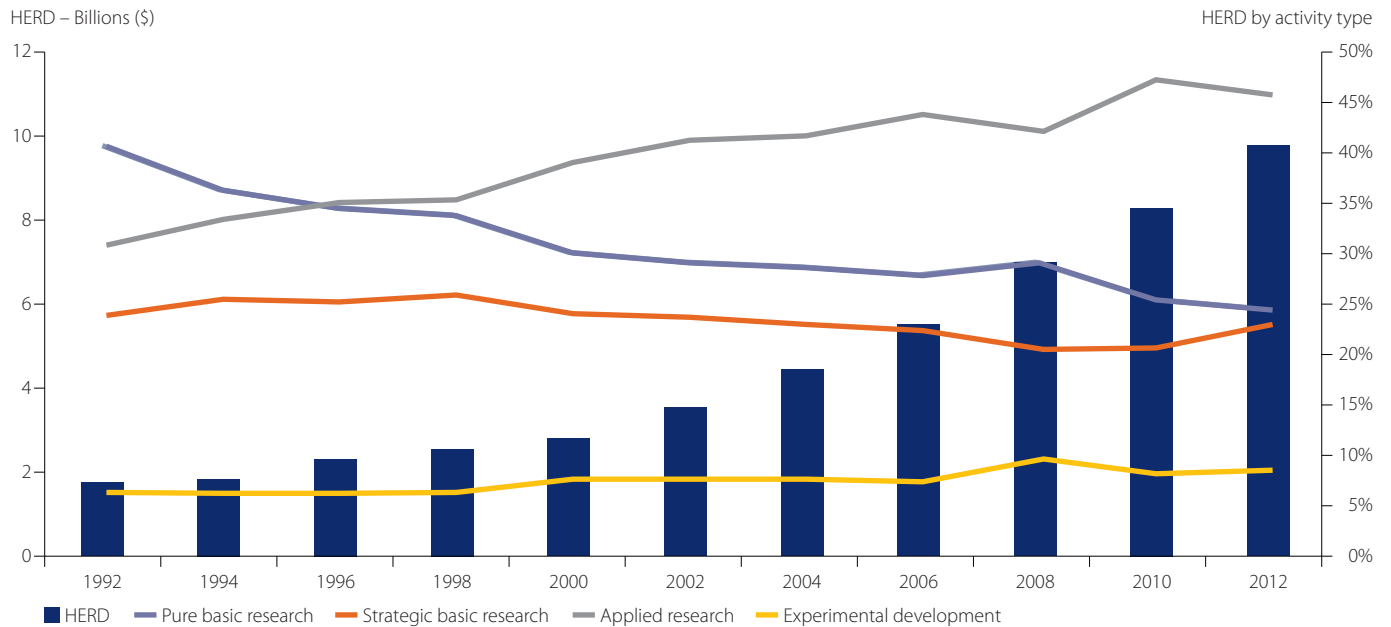


significantly changed, from a sector characterised by basic research, to one characterised by applied research (**Figure 1**). While in the early 1990s, pure basic and strategic basic accounted for 60 per cent of research activity combined, with 'applied research' comprising only around 30 per cent, in 2010, the balance shifted for the first time, with applied research reaching 47 per cent.

While the division between basic research and applied research is in many ways artificial, the directional change towards research with identified applications such as productivity gains, policy development and economic activity. is an important marker of the importance of university-based research to social and economic transformation.

In an address to the Australian Parliament, then Federal Minister for Industry and Science, the Hon. Ian Macfarlane MP, outlined how science and innovation would form the basis for Australia's future industry policy. This proposal highlighted the need to ensure that existing industries are made more competitive and are enriched by advances in research, while at the same time creating new innovative industries:

*To succeed and to guarantee our future prosperity we need to harness science and innovation for the national interest. We must get a bigger bang for our science dollar. And we must use science and innovation to drive a dynamic, entrepreneurial start-up system to secure future growth and jobs.[5]*

These sentiments are reinforced by the outcomes of the recent *Review of Research Policy and Funding Arrangements*, undertaken by Dr Ian Watt AO[6] and the Government's *National Innovation and Science Agenda*.[7]

## University research assessment in Australia

Despite the growing importance of public research to Australia's social and economic prosperity, the Australian innovation system still does not include ways to measure and evaluate the interactions between public researchers and research end-users across the public, not-for-profit and private sectors. In its *Industry, Innovation and Competitiveness Agenda*, the Federal Government has identified the important role that 'improve[d] assessment of the research system'[8] will play in shaping the Australian public research sector.

4    ABS (2012), *Research and Experimental Development, Higher Education Organisations*. http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/8111.02012?OpenDocument.

5    Ministerial Statement (August, 2015), *Science and Innovation Building Australia's Industries of the Future*. http://minister.industry.gov.au/ministers/macfarlane/speeches/ministerial-statement-science-and-innovation-building-australias

6    https://docs.education.gov.au/node/38976

7    http://www.innovation.gov.au/

8    Australian Government, *Boosting the commercial returns from research* (2014) p.24.https://www.education.gov.au/news/discussion-paper-boosting-commercial-returns-research-released

In the case of universities, assessment has traditionally been conducted by peer review and more recently using metrics such as journal-to-journal citation rates as a proxy for research 'excellence'. However, it is now acknowledged that these measures create an evaluation gap between the various missions of universities (such as knowledge production, improving health outcomes, realising economic benefits, driving social good, and innovation and a narrow focus on publications in academic journals[9]). The traditional indicators used to measure research performance, such as journal quality and citation data, can limit the type of work that researchers are willing to undertake.[10] This highlights the need to go beyond traditional proxies of research quality towards measures more clearly related to the multiple missions of universities.[11]

In the Australian university sector, there are already effective financial and prestige-based incentives that focus researchers on producing high-quality research publications. For example, Excellence in Research for Australia (ERA) encourages a focus on research publication by evaluating research using peer review and citation metrics. The federal Department of Education and Training rewards this, allocating approximately $77 million in 2015[12] on ERA outcomes through the Research Block Grants (RBG). The behaviours that ERA drives in our university sector have been even greater than might be anticipated from this small amount of funding.[13]

## The role of research engagement

While research excellence is desirable in its own right, it is not a sufficient driver of innovation and is only one dimension of the mission of universities. A focus on excellence is often at the expense of other important activities such as university collaborations with the private and public sectors, entrepreneurial behaviour and knowledge transfer.[14]

In the UK a focus on both research excellence and knowledge transfer/research engagement – through the Higher Education Innovation Fund (HEIF)[15] – has stimulated important links between universities and research end-users. The HEIF is a performance-based mechanism that allocates around 10 per cent of the UK RBGs based on universities' knowledge exchange income (income received from research end-users). Modelling indicates that each £1 invested by government in HEIF has generated £7.30 in additional knowledge exchange income. Over the past decade this accounts for around £3.1 billion (AU$6.7 billion) in knowledge exchange income, coming in large part from the private sector. There is a significant body of evidence[16] confirming the direct social and economic impacts that follow from such policies, and activities such as research engagement and knowledge exchange are forward indicators of potential research impact. For example, in the UK 31 per cent of large businesses collaborate with higher education or public research agencies on innovation – in Australia this figure is 3.5 per cent. Such performance has seen Britain ranked 2nd in a recent Global Innovation Index compared with Australia's ranking of 17th.[17]

Calls to address the evaluation gap in Australia have increasingly been heard from government and industry. As outlined in *Boosting the Commercial Returns from Research*, research translation is a key aspect of the Government's *Industry, Innovation and Competitiveness Agenda*:

> *Better translation of research into commercial outcomes is a key part of this [agenda] and will help drive innovation in Australia, grow successful Australian businesses and research capacity, and boost productivity and exports. It aligns with the Government's measures to reform the higher education sector and to realise the potential of health and other research.[18]*

An important step to achieve this is to improve assessment of the research system, including improved metrics on engagement and knowledge transfer with industry, as well as research outcomes and impact.[19]

This critical role of research engagement is reflected in recommendations from the *Review of Research Funding and Policy Arrangement*s which include assessing the economic, social and other benefits of university research through an impact and engagement assessment framework.[20]

9    Paul Wouters, *A key challenge: the evaluation gap* (2014). https://citationculture.wordpress.com/2014/08/28/a-key-challenge-the-evaluation-gap/

10   Sarah de Rijcke, *Towards best practices for research assessment: Effects of indicators and the Leiden Manifesto* (August 2015). http://www.slideshare.net/sarahderijcke/toward-best-practices-for-research-assessment-effects-of-indicators-and-the-leiden-manifesto

11   Diana Hicks et al, *Bibliometrics: The Leiden Manifesto for research metrics* (23 April 2015). Nature, Volume 520, pp. 429–431.

12   60 per cent of SRE Threshold 2 ($129 million).

13   See for example: ACIL Allen, *Benefits Realisation Review of Excellence in Research for Australia* (2013). Available at: www.arc.gov.au/Publications.

14   Australian Council of Learned Academies, *The role of science, research and technology in lifting Australian productivity* (2014), pp74-75. http://www.acola.org.au/index.php/projects/securing-australia-s-future/project-4

15   http://www.hefce.ac.uk/kess/heif/

16   http://impact.ref.ac.uk/CaseStudies/Results.aspx?val=%22heif%22%20%22higher%20education%20innovation%20fund%22

17   *English universities reap benefits of private sector links*. The Australian, September 23 (2015).

18   Australian Government, *Boosting the commercial returns from research* (2014) p.22. https://www.education.gov.au/news/discussion-paper-boosting-commercial-returns-research-released

19   *Ibid*, p24.

20   https://docs.education.gov.au/node/38976

# Research Engagement for Australia

Throughout 2014 and 2015, ATSE has undertaken work to develop Research Engagement for Australia (REA). This work is intended to help bridge the evaluation gap and to ensure that research engagement between Australian universities and research end-users across the public, not-for-profit and private sectors is appropriately recognised and rewarded alongside other measures of university activities.

## Research Engagement for Australia Proposal

In March 2015, with the support of the Department of Education and Training, ATSE released the REA Proposal, *Research Engagement for Australia: Measuring research engagement between universities and end users*. The report was written with input from an expert Steering Committee comprised of members from across the higher education sector and Government. The group included representatives from the four Learned Academies, as well as research leaders and senior executives from the Department of Education and Training, the Department of Industry and Science and the Australian Research Council (Appendix B).

The REA Proposal outlined three research engagement metrics under the banner of Research Engagement for Australia. The REA Proposal demonstrated that it was feasible to create meaningful research engagement metrics from existing university research data collections. Further, the REA Proposal found that the REA metrics identify activities in the university that are not well captured by existing research evaluation systems (such as ERA).

## Research Engagement for Australia Pilot

Following from the REA Proposal, ATSE received additional support from the South Australian and Queensland State Governments to conduct a REA Pilot exercise in collaboration with universities in the two States, with two key objectives:

1. Demonstrate that universities can participate in REA without creating additional resourcing burdens by conducting a Pilot of the REA Metrics with South Australian and Queensland universities; and
2. Work with South Australian and Queensland universities to refine the REA Metrics and methods for future implementation nationally.

Between April-October 2015 ATSE undertook the REA Pilot with the aim of demonstrating its feasibility as a robust, intuitive and low cost approach to measuring research engagement.

All universities from the two States participated in the REA Pilot, including:

### South Australia

> Flinders University

> The University of Adelaide

> The University of South Australia

### Queensland

> Bond University

> Central Queensland University

> Griffith University

> James Cook University

> Queensland University of Technology

> The University of Queensland

> The University of Southern Queensland

> The University of the Sunshine Coast

## Conducting the Pilot

Each university was asked to provide relevant data from their ERA 2012 (and in the case of Queensland universities, their 2012 and 2015) submissions. This included financial data required as inputs into the REA Metrics, as well as corresponding staffing data. Additional data were sourced from publicly available datasets, including university revenue data which were sourced from the Department of Education and Training's *Financial Reports of Higher Education Providers*.

One of the primary aims of the REA Pilot was to prove that the approach of re-purposing existing data collections within the universities was a time- and cost-effective approach to measuring research engagement. This was confirmed – overall, universities were able to easily and quickly participate in the data provision, making use of the existing systems in support of other internal and external reporting requirements such as ERA and HERDC.

The REA Pilot demonstrated that the compliance burden for universities of REA is very small, and the decision to make use of existing data collections and university systems makes for a quick and resource-light approach to obtaining research engagement data.

## Results from the Pilot[21]

During the REA Pilot, participating universities were invited to comment on results calculated for their assessed Units of Evaluation (UoEs). This allowed for a number of elements of REA to be verified in consultation with the universities, including that:

> Strong REA performance relates to ongoing research engagement activities within the university in a given two-digit discipline;

> REA performance broadly meets the expectations of the university in terms of their areas of strong research engagement;

> REA measures aspects of research activity that are not rewarded through existing measures, such as ERA.

Each of these points was confirmed in the REA Pilot. While there were cases where pockets of strong engagement activity were not identified by the REA Pilot results, in most cases participating universities were able to relate strong results on REA to an underlying program of research engagement. Additionally, where there was strong performance this accorded broadly with where institutions believed they had a discipline that was focussed on research engagement activities.

In general, the REA metrics were considered useful as means of measuring important aspects of research engagement performance. The REA Metrics provide a multi-dimensional picture of research engagement productivity, share of the national engagement activities, and research focus of an institution in each two-digit discipline.

## Findings of the Pilot

The REA Pilot demonstrated that the cost of implementing REA is low, both for the higher education sector and for Government. The potential returns from a focus on research engagement – social returns, improved productivity, developing and supporting future innovative industries – are high. REA can be implemented quickly as it makes use of existing data and collection processes. Given the likely behavioural changes that will follow from REA, this will ensure that the returns can be expected in the short-to-medium term.

The findings from the REA Pilot are:

> REA could be adopted as a direct way of measuring research engagement and as a forward indicator of potential research impact;

> REA Metrics serve as proxies for additional research engagement activities in universities that are not directly measured by the REA Metrics, for example, where research engagement takes the form of in-kind support;

> There are low resourcing requirements associated with REA – the REA Pilot created very little burden for participating universities and the approach of making use of existing data within the university leverages well established systems and processes in support of Government reporting requirements;

> Institutions participating in the REA Pilot generally accepted the outcomes as robust, transparent and meaningful. Institutions verified that the results corresponded to actual research engagement activities and that strong performance in REA corresponded to perceived areas of strong research engagement; and

> Additional enhancements to the REA approach and methodology would increase reliability of the REA outcomes.

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21    Detailed analysis of the REA Pilot results is provided in Appendix C.

# Outline of Research Engagement for Australia

## What does REA measure?

### Direct measures

REA is a research measurement tool designed to assist in delivering on the promise of a more engaged and entrepreneurial higher education research sector into the future. In distinction from other approaches, such as research impact evaluation, the focus of REA is on the processes in support of research engagement rather than its outcomes.[22] The key and simplifying principle used in REA is to use external dollars attracted from industry and other end-users of research as a direct measure of research engagement and as a forward indicator of potential research impact.

Under REA, two aspects of this are directly measured: income derived from external research partners (across the public, private and not-for-profit sectors) and income derived from the commercialisation of university-based research. This corresponds to the missions of meeting the needs of existing public, not-for-profit and private sector groups and to improve competitiveness, while at the same time creating new innovative industries.

### Indirect measures

There are a range of important engagement activities undertaken in universities that are not directly measured under this approach, for example, educational activities, in-kind support provided to universities and broader community engagement. In most instances data are not systematically collected by universities for these activities – for example, while universities indicate levels of in-kind support provided on ARC Linkage Grants, these figures are not routinely collected and audited. Though REA does not directly measure such activities, the financial support provided to universities by research end-users and commercialisation income can serve as a proxy for these activities. These direct measures will correspond to the broader level of institutional research engagement activity and structures in place to support research engagement – i.e. the presence of more or less research engagement income in a university will correlate

highly with the overall levels of research engagement activities undertaken in that university. Insofar as income from external research partners and income from research commercialisation will correlate closely with other measures of research engagement (such as in-kind support etc.), it is a robust proxy measure for these broader research engagement activities.

## Data used in REA[23]

One of the underlying principles of REA is to minimise reporting requirements and additional costs to the higher education sector. As such, REA makes use of existing data collections. Specifically, REA uses data reported by universities to the Australian Research Council (ARC) under ERA. REA uses 3 years of income data[24] to ensure that yearly fluctuations in any one or more of the categories do not affect the performance of a university.

REA is focussed on measuring and identifying research engagement and uses income derived from research end-users and commercialisation income to do this. The REA Pilot included the following data derived from universities' ERA submissions:

> Select Australian Competitive Grants that include a non-university partner contribution (Higher Education Research Data Collection (HERDC) Category 1, being ARC Linkage Grants, NHMRC Development Grants and NHMRC Partnership Grants only)[25]
> Other Public Sector Research Income (HERDC Category 2)
> Industry and Other Research Income (HERDC Category 3)[26]
> Cooperative Research Centres (CRC) Income (HERDC Category 4)
> Research Commercialisation Income

Using the Australia and New Zealand Standard Research Classification (ANZSRC) Field of Research (FoR) codes, Units of Evaluation (UoE) are created, which are the two-digit research disciplines for each Australian university[27] – an example of a UoE from the REA Pilot is '01 – Mathematical Sciences' at the University of Queensland, which in REA would correspond to a UoE identified as 'UOQ-01'.

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22    For a detailed discussion see S Upton et al. *From outcomes to process: evidence for a new approach to research impact assessment*. Research Evaluation (2014), 23, pp352-365.

23    Enhancements to these data are recommended in this report for future implementation of REA.

24    In the REA Pilot, for example, universities provided data for the years 2008–2010 and 2011–2013, respectively, from the ERA 2012 and 2015 data collections.

25    Additional Category 1 Grants are recommended for future iterations of REA in Appendix D.

26    This includes sub-categories 'Australian', 'International A' and 'International B'; 'HDR fees for domestic students' and sub-category 'International C: HDR fees for international students' have been excluded.

27    The FoR is a hierarchical research classification with three levels: Divisions (two-digits), Groups (four-digits) and Fields (six-digits). Two-digit Divisions are based on a broad research discipline; four-digit Groups within each Division are research areas which share the same broad methodology, techniques and/or perspective as others in the Division; each four-digit Group in turn is a collection of related six-digit Fields. Each FoR is represented by a unique reference code. So, for example, within the two-digit Division of '01 – Mathematical Sciences' is the 4-digit Group of '0102 – Applied Mathematics'. Within this is the 6-digit Field of '010201 – Approximation Theory and Asymptotic Methods'. Evaluation in REA takes place at the two-digit Division within the university, so for example, a UoE might be '01 – Mathematical Sciences' at the University of Queensland.

## The REA Metrics

Three REA Metrics have been developed. These are used to measure the research engagement performance of participating universities. Each metric is designed to measure a distinct aspect of universities' research engagement activities. The three REA Metrics are[28]:

> **Engagement per FTE (M1)** – This is a productivity-based metric measuring the research engagement income per FTE by UoE;

> **Share of National Engagement Activity (M2)** – This is a volume-based metric demonstrating how much research engagement income each university receives of the national total of UoEs; and

> **Engagement Intensiveness (M3)** – This metric demonstrates whether a university has a particular research engagement focus in a UoE relative to other UoEs within the university.

In each REA Metric, the income data outlined above are used as numerators to measure performance; in order to derive the three unique REA Metrics, additional data are introduced as denominators. Each REA Metric uses a unique denominator that captures a distinct dimension of research engagement activities.[29] The three REA Metrics are described in detail below: each outline includes a worked example.

### Engagement per FTE (M1)[30]

In Engagement per FTE (M1), the sum of the income for a UoE is divided by the sum of the FTE for the same UoE. The resulting figure is the total amount of relevant income per FTE in a two-digit discipline in a university.

$$\frac{Relevant\ Category\ 1_{UoE} + Category\ 2_{UoE} + Category\ 3_{UoE} + Category\ 4_{UoE} + Commercialisation\ income_{UoE}}{FTE_{UoE}}$$

**Example:** In Mathematical Sciences (FoR code 01) 'University of X' has $250,000 of ARC Linkage grants (Relevant Category 1), $40,000 Other public sector income (Category 2), $120,000 of Industry and other income (Category 3), $20,000 of CRC income (Category 4) and $10,000 of Research Commercialisation income for a total of $440,000. There are 20 research active FTE in Mathematical Sciences at 'University of X.' The total is divided by the FTE, which results in a metric of $22,000

### Share of National Engagement Activity (M2)

In Share of National Engagement Activity (M2), the sum of the inputs for a UoE is divided by the sum of the same inputs for the relevant two-digit FoR nationally. The resulting figure is the relative share for the university, of the relevant income, for that FoR nationally. This provides a volume based measure that can be compared within disciplines.

$$\frac{Relevant\ Category\ 1_{UoE} + Category\ 2_{UoE} + Category\ 3_{UoE} + Category\ 4_{UoE} + Commercialisation\ income_{UoE}}{Relevant\ Category\ 1_{FoR} + Category\ 2_{FoR} + Category\ 3_{FoR} + Category\ 4_{FoR} + Commercialisation\ income_{FoR}}$$

**Example:** In Mathematical Sciences (FoR code 01) 'University of X' has $250,000 of ARC Linkage grants (Relevant Category 1), $40,000 Other public sector income (Category 2), $120,000 of Industry and other income (Category 3), $20,000 of CRC income (Category 4) and $10,000 of Research Commercialisation income for a total of $440,000.

Nationally for Mathematical Sciences (FoR code 01) there are $7.5M of ARC Linkage grants, NHMRC Development Grants and NHMRC Partnership Grants (Relevant Category 1), $21M Other public sector income (Category 2),  $20.5M Industry and other income (Category 3), $4.5M 'CRC income (Category 4) and $15M of Research Commercialisation income which results in a FoR total of $68.5M.

The total for 'University of X' in Mathematical Sciences is divided by the national total for Mathematical Sciences which results in a metric of 0.006.

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28    Calculations of the metrics are outlined below.

29    Two additional data elements are included in the calculation of REA Metrics: FTE data and data on university revenue, as outlined below.

30    FTE data are sourced from the corresponding ERA submission.

## Engagement Intensiveness (M3)

In Engagement Intensiveness (M3), the sum of the inputs for a UoE is divided by the university's Total revenue from continuing operations.[31] The resulting figure shows the relative focus of the university in a particular two-digit FoR code relative to its size. As distinct from volume and productivity, this metric provides information about the intensiveness of a university in a given discipline relative to its intensiveness in other disciplines, and relative to other universities.

$$\frac{\textit{Relevant Category 1}_{UoE} + \textit{Category 2}_{UoE} + \textit{Category 3}_{UoE} + \textit{Category 4}_{UoE} + \textit{Commercialisation income}_{UoE}}{\textit{Total revenue from continuing operations}_{University}}$$

**Example:** In Mathematical Sciences (FoR code 01) 'University of X' has $250,000 of ARC Linkage grants (Relevant Category 1), $40,000 Other public sector income (Category 2), '$120,000 of Industry and other income (Category 3), $20,000 of CRC income' (Category 4) and $10,000 of Research Commercialisation income for a total of $440,000.

The Total revenue from continuing operations for 'University of X' is $750M.

The total for the UoE, of 'University of X' in Mathematical Sciences, is divided by the Total revenue from continuing operations which results in a metric of 0.0006.

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31    Revenue data are sourced from the Department of Education and Training's *Financial Reports of Higher Education Providers* collection.

# Research Engagement for Australia Deployment

As recommended in the *Review of Research Policy and Funding Arrangements* and as outlined in the *National Innovation and Science Agenda*, the REA will inform development of a national assessment of the economic, social and environmental aspects of university research.[32]

In advance of deploying REA, a series of enhancements are proposed to refine the REA Metrics and methodology. These have been developed in consultation with universities participating in the REA Pilot. Detailed enhancements to REA are recommended in Appendix E; these cover a range of aspects, including enhancements related to the REA methodology (including the REA Metrics) and enhancements related to the REA approach (including data verification and reporting).

## Implementing Research Engagement for Australia

There are different approaches that could be taken to implement REA. The following aspects of implementation are discussed in depth in below:
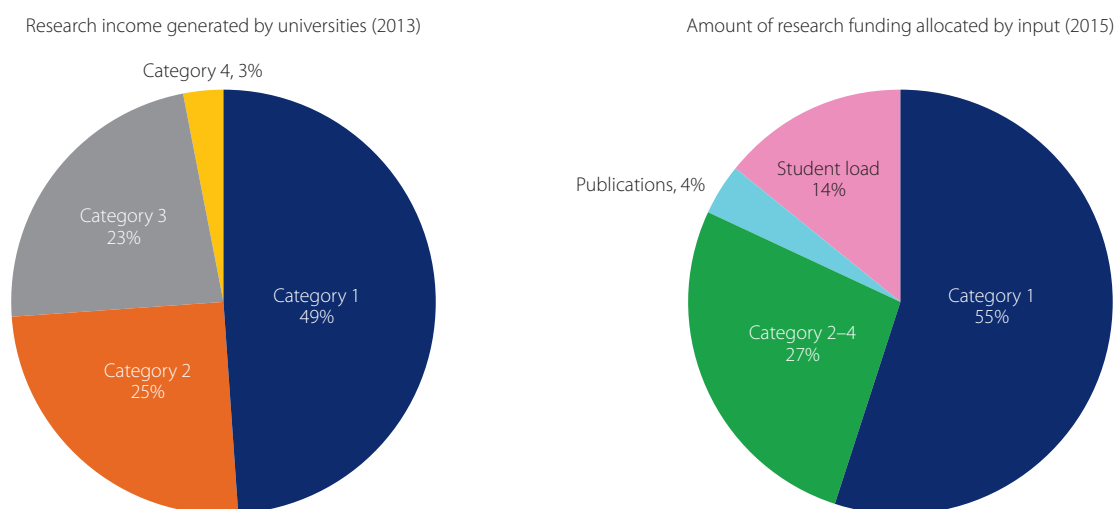
> How the REA Metrics may be used as inputs into funding allocations;

> How the REA Metrics may become part of a panel-based evaluation; and

> How the REA Metrics could be used as the basis for deriving rankings.

## How the REA Metrics may be used as inputs into funding allocations

In Australia, long term funding stability for university research is provided through the Research Block Grants (RBGs). The short-medium term behavioural change that the RBGs can drive has been well documented. For example, the introduction of a publication quantum in the 1990s was accompanied by dramatic increases in the research productivity of Australian academics; between 1988-1997 Australia's share of publications in the Science Citation Index (SCI) increased 25%. [33] In this case, direct financial outcomes drove important individual and institutional behaviour. At present, the financial rewards for obtaining HERDC Category 2-4 income and commercialisation income are potentially undervalued in the allocation of RBGs. **Figure 2** shows the amount of funding generated by Australian universities against HERDC income categories, compared with how that income influences the block grant allocations under the Research Infrastructure Block Grant (RIBG), Sustainable Research Excellence (SRE) and Joint Research Engagement (JRE) components.

## Figure 2 University research income compared with university research block grant allocation inputs[34]

Research income generated by universities (2013)

Amount of research funding allocated by input (2015)



Category 4, 3%
Category 3 23%
Category 1 49%
Category 2 25%

Publications, 4%
Student load 14%
Category 1 55%
Category 2–4 27%

32      http://www.innovation.gov.au/page/measuring-impact-and-engagement-university-research

33      Linda Butler, *Explaining Australia's increased share of ISI publications – The effects of a funding formula based on publication counts* (2003). Research Policy, volume 32, pp. 143-155.

34      Research Infrastructure Block Grant (RIBG), Sustainable Research Excellence (SRE) and Joint Research Engagement (JRE) components.

In the context addressing this imbalance in reward mechanisms and recognising the importance of research engagement through institutional incentives such as the RBGs, REA may be implemented as a performance index. There are a number of advantages to this approach:

> REA demonstrably measures an element of university research activities that are not already captured in ERA's quality-based outcomes. In this respect REA provides an important additional dimension to research performance, and thus its introduction is likely to result in real behavioural changes if accompanied by financial outcomes.

> The REA ranking methodology (outlined below) allows for an agile policy instrument that can be adjusted over time to weight certain outcomes (e.g. volume, productivity, institutional focus) more than others, depending upon the current needs of the sector; REA can derive three individual metrics; these can be aggregated into an overall REA Index of performance.

The underlying arguments behind this approach have been adopted by the *Review of Research Policy and Funding Arrangements* in its recommendations for altering the RBG formulae.

## How the REA Metrics may be used to develop a panel-based evaluation

The introduction of ERA in 2008 has demonstrated the effectiveness of peer evaluation mechanisms in driving behavioural changes. As noted in a recent survey of universities, 66 per cent identified that ERA had contributed to the improved quality of research because it has driven a "shift from an emphasis on research quantity to research quality [including] a focus on publishing research in high quality internationally-recognised journals."[35]

This has been achieved with little funding attached. Through the SRE component of the RBGs, ERA delivered only around $77m in 2015. The success of ERA can be put down to the use of peer evaluation and associated peer esteem that this generates. Such effects have been observed in a number of international performance based research assessments:

> *the systems have strong effects on universities, though less through the incentives funding provides than through public judgments about relative prestige. Comprehensive assessment of universities and their departments creates intense interest among universities.* [36]

As it stands, the ERA 2015 round has focussed on research quality as measured through peer review and citation data, the outlets that academics publish in, and the Category 1 funding that they receive from the Commonwealth. While Category 2-4 funding and commercialisation funding are collected, they do not feature highly in the evaluations.

To ensure that research evaluation in Australia is not one-dimensional, a similar process of expert review could be incorporated into REA. While in ERA, expert panels are convened on a discipline-by-discipline basis, such arrangements could be avoided for REA. Instead, a small panel of experts trained in the REA methodology and underlying data could bring expert judgement to bear on the final allocation of ratings. This would involve analysing and verifying the REA metrics, the underlying data, and the additional contextual information.

While, for example, in the UK the Research Excellence Framework (REF) combines excellence and impact into a single outcome, it is preferable in Australia to keep research quality evaluation a separate exercise from REA. As separate evaluation exercises, research excellence and research engagement make more useful tools for university planning and management. This assists in supporting the multiple missions of universities.

This approach has the advantage of introducing peer evaluation of the REA Metrics, which is considered to be best practice for research evaluation mechanisms.[37]

## How the REA Metrics could be used as the basis for deriving rankings

It is a long established principle in research evaluation that "indicators change the system through the incentives they establish".[38] The efficacy of research rankings in changing institutional priorities has been clearly demonstrated in the high importance that universities place on global ranking exercises such as the Times Higher Education and Shanghai rankings, and the behaviours that have been encouraged to maximise performance on such rankings (including restrictive publication practices, amongst other things). These external ranking mechanisms drive behavioural changes based on a combination of public reputational value (where the rankings are used by universities for promotional activities) which in turn deliver secondary financial rewards (when students consult rankings to inform their decision-making on where to study). The value proposition for rankings is their public nature, with the more highly disseminated rankings having more influence over institutional behaviours. The reputation of the ranking agency, therefore, plays an important role in terms of providing legitimacy to the ranking exercise.

35    ACIL Allen, 20-21.

36    Diana Hicks, *Performance-based university research funding systems* (2012). Research Policy, volume 41, pp. 251-261.

37    The Leiden Manifesto, http://www.nature.com/news/bibliometrics-the-leiden-manifesto-for-research-metrics-1.17351

38    The Leiden Manifesto, http://www.nature.com/news/bibliometrics-the-leiden-manifesto-for-research-metrics-1.17351

Another important aspect of rankings that drives institutional behaviours is that they allow for universities to improve their rank over time – without this the incentive structure is unlikely to be effective. For this reason, the large global ranking agencies have increased the frequency and type of rankings that they publish, moving from single annual exercises, to more and more disaggregated components that appear with greater frequency throughout the course of the year.

Taking account of this, it is possible to envisage that REA could influence universities to value research engagement activities more highly if it were administered as a public ranking exercise. The effectiveness of this would rely in great part on the perceived legitimacy and authority of the administering organisation.

## Deriving the REA Index

One of the complicating factors in deriving final outcomes for REA is that this will be shaped by the policy purpose to which the outcomes are put. For example, if REA were simply a ranking exercise, where universities were ranked from highest to lowest

performance in each discipline, this could be simply achieved; however, if the outcomes are to be used as the basis of a funding allocation, then additional transformations would be required to have suitable inputs into such formulae. In this respect it is difficult to determine what the optimal approach to deriving final outcomes would be for REA. However, a number of different options have been considered, and a general approach to deriving an REA Index is has been developed.[39]

As a general principle, the following approach has focussed on deriving a flexible ranking methodology that can accommodate multiple implementation options (as outlined above).

### Ranking methodology

The proposed methodology is to generate a single REA Index based on a common method of aggregating multi-dimensional statistics. This involves normalising the inputs (in a statistical sense) and deriving a weighted aggregate. The overall REA Index is based on a simple geometric mean of the three normalised metrics M1, M2 and M3 (Appendix F includes the detailed methodology for calculating the REA Index).[40]

**Figure 3 REA Index calculated for all UoEs by FoR (anonymised data from REA Proposal)**

REA Index



Field of Research (FoR)

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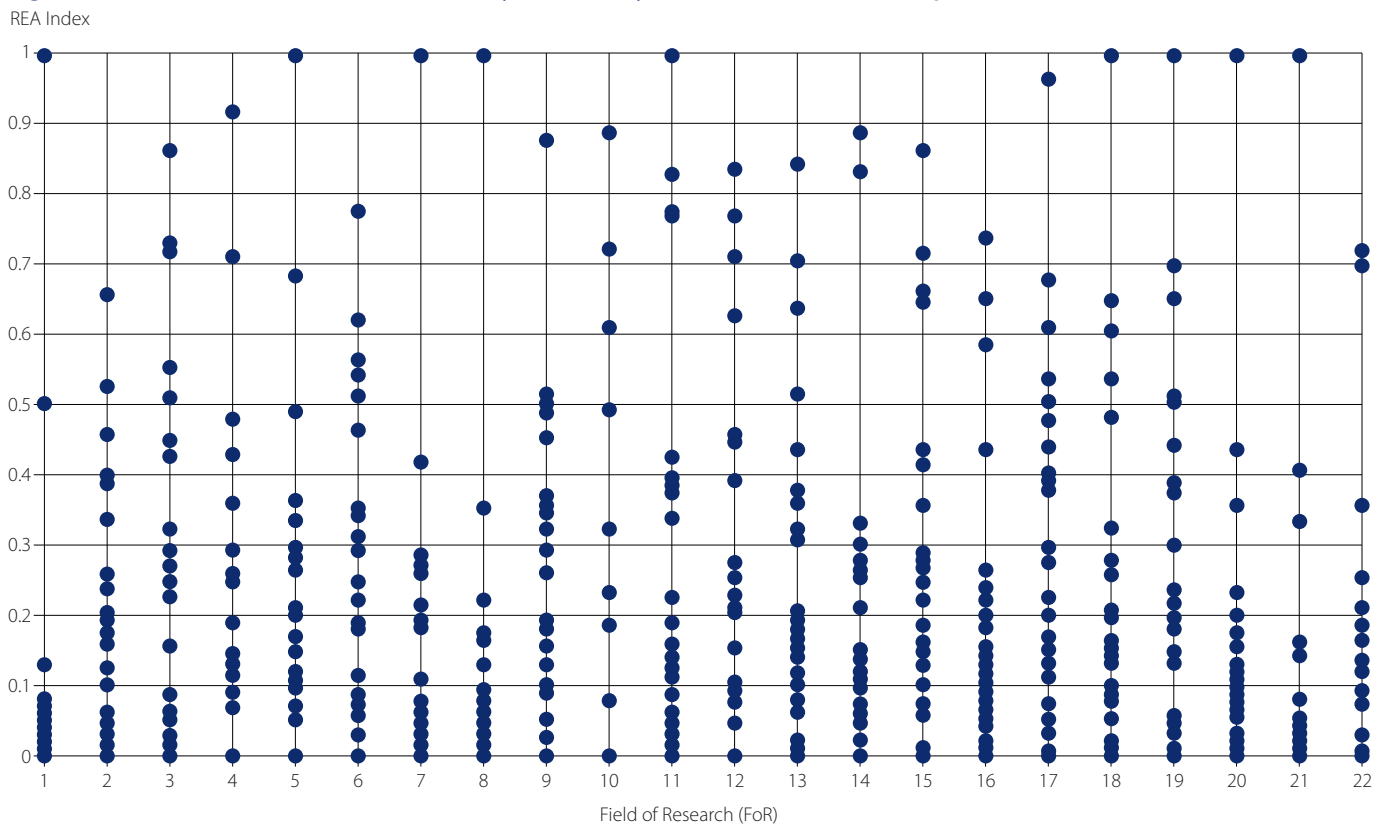
39      Thanks are given to the Economic and Market Analysis Branch in the Research and Economic Group of the Department of Education and Training for developing this approach.

40      Appendix F includes examples of how the different metrics could be used to derive different indices (for example, an 'REA Index' could be derived using M2 and M3 if M1 if required).

The expected output of this method is a single-number index measuring the relative performance of each institution across each field of research incorporating the three REA Metrics. **Figure 3** shows the REA Index calculated using anonymised data.

In addition to the aggregate REA Index the intermediate stage indices (the normalised REA Metrics) can also be used in their own right for comparisons across disciplines, institutions and across metrics.

There are a range of advantages to this methodology, including:

> The REA Index can be calculated quickly and updated regularly.
> It provides a consistent method of ranking individual institutions (with a possibility of deriving a similar index for selected overseas universities to provide an international context where data are available).
> It is suitable for making comparisons over time.
> There is scope for testing an appropriate weighting scheme where one or more of the REA Metrics can be assigned preferential weighting to reflect policy priorities.

There are some limitations to this approach, however they pose no barrier to implementing this methodology. These include:

> The issue of appropriate weightings for the REA Metrics in the overall REA Index may detract from the main message of the ranking.
> Like any index, a single value of the index cannot be directly interpreted, and its value lies in being able to be compared.

# Discussion of implementation options

None of the options presented above are mutually exclusive of each other. Throughout the REA Pilot it has become clear that the preferred implementation likely involves elements of all of the options above.

Several elements are considered important:

> **Expert judgement is crucial to the REA outcomes.**
As outlined above, there are significant advantages to including a level of expert review of the data used in REA. This will lend credibility to the results. This will also provide a sophisticated set of evaluation criteria to be developed that will assist in interpreting the outcomes of REA. An expert panel, similar to the ERA panels (though distinct from them), is a crucial enhancement to the REA evaluation process. These panels will examine the calculated metrics, additional contextual information, and the proposed REA Index[41] to assist with assigning final ratings to UoEs.

> **A national trial of REA should be conducted.**
REA should be run as an independent exercise from other research evaluation mechanisms. As outlined in the recent Review of Research Policy and Funding Arrangements report the REA approach should be trialled nationally in 2017.[42] This will assist in implementing the recommended enhancements in Appendix E and test all universities' systems and capacity to participate in REA.

> **The first national round of REA should not be tied directly to funding outcomes.**
The REA Pilot demonstrated that the data collection process is simple to implement and that the results are robust. However, this report proposes a number of enhancements to the methodology and approach for implementing REA nationally. These enhancements, and scaling the exercise up to a national evaluation, will have implications for the implementation of REA and its outcomes. In order for universities to become accustomed to these it is important that there are no financial outcomes for the initial round.

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41    These panels may also potentially have access to the explanatory vignettes proposed in this report.

42    Ian Watt, *Review of Research Policy and Funding Arrangements Report* (2015). https://docs.education.gov.au/node/38976

# Conclusion

Australia undertakes world-class scientific research through universities and other publicly funded research organisations. Science and innovation are at the heart of Australia's future industry policy, and are key to economic and social transformation and prosperity. Two key aspects affecting Australia's ability to translate research into broad benefits for the nation are:

> Ensuring that research can be absorbed into existing industries and policy development by fostering high levels of engagement between Australia's university researchers and research end-users across the private and public sectors; and

> Fostering an entrepreneurial university research culture capable of creating new and innovative industries from the research base to fuel economic development and provide growth of highly skilled jobs.

Despite the importance of research engagement to Australia's future, there are still no adequate measures of the interactions between public researchers and research end-users across the public and private sectors. In the case of universities, assessment is still based on peer review and metrics such as journal to journal citation rates are used as a proxy for research excellence. This limited focus risks creating an evaluation gap between the various missions of universities (such as knowledge production, realising economic benefits, driving social good and innovation, and a narrow focus on publications in academic journals).

Improved research assessment mechanisms that reflect the diverse missions of universities should be a key priority shaping publicly funded research. While research excellence is desirable in its own right, it is not a sufficient driver of innovation and is only one dimension of the research mission of universities.

REA is a measurement tool designed to assist in creating a more engaged and entrepreneurial higher education research sector. It uses external dollars attracted from industry and other end-users of research as a direct measure of research engagement and as a forward indicator of research impact. REA does this by measuring income derived from external research partners and income derived from the commercialisation of university-based research.

REA uses three metrics to measure the research engagement performance of universities. Each metric is designed to measure a distinct aspect of universities' research engagement activities. The three REA Metrics are:

> **Engagement per FTE** – This is a productivity-based metric measuring the research engagement income per FTE by UoE.

> **Share of National Engagement Activity** – This is a volume-based metric demonstrating how much research engagement income each university receives of the national total UoE.

> **Engagement Intensiveness** – This metric demonstrates whether a university has a particular research engagement focus in a UoE relative to other UoEs within the university.

The REA Pilot, conducted by ATSE, has confirmed that REA is a cost-effective and robust measure of research engagement: universities were able participate in the data provisions, making use of the existing systems in support of other internal and external reporting requirements such as ERA and HERDC, and with minimal resourcing burdens. The results of the REA Pilot, provided to universities, provided an intuitive and believable method of measuring research engagement. Strong REA performance was related to ongoing research engagement activities within the university and broadly accorded with the expectations of the university in terms of their perceived areas of strong research engagement. In addition, the REA Pilot confirmed earlier findings from the REA Proposal that REA measures aspects of research activity that are not rewarded through existing measures, such as ERA.

Given the results of the REA Pilot, it is important that REA be deployed as a priority. REA should be trialled nationally in 2017 as per the recommendations of the recent *Review of Research Policy and Funding Arrangements* report. This should involve expert review panels who utilise the REA metrics, the additional contextual data and the REA Index in determining outcomes.

In advance of deploying REA, a range of enhancements are proposed to better focus the REA methodology and approach on measuring research engagement. Some of the enhancements outlined in this report will require additional data collection and processing for universities, but are not estimated to be large. In addition, depending on the policy setting used to deploy REA, these costs could be potentially offset by funding (e.g. RBG).

The cost of implementing REA would be low, both for the higher education sector and for Government. The potential returns – social returns, improved productivity, developing and supporting future innovative industries – are high. Further, REA can be implemented quickly as it makes use of existing data and collection processes. Given the likely behavioural changes that will follow from REA, this will ensure that the returns can be expected in the short-to-medium term. Implementing REA as a means of improving the assessment of university-based research would therefore seem a priority.

# Appendices

**Appendix A – Types of Research Activity**

**Appendix B - Research Engagement for Australia Steering Committee**

**Appendix C – Detailed analysis of the REA results**

**Appendix D – Additional Commonwealth Schemes for inclusion in REA from ACGR**

**Appendix E – Recommended Enhancements to REA**

**Appendix F – Detailed REA Index ranking methodology**

**Appendix G – Calculation of National Averages for the REA Pilot**

**Appendix H – RRDC Income Data**

# Appendix A – Types of Research Activity

Universities report research activities to the ABS as follows[43]:

> **Pure basic research** is experimental and theoretical work undertaken to acquire new knowledge without looking for long term benefits other than the advancement of knowledge;

> **Strategic basic research** is experimental and theoretical work undertaken to acquire new knowledge directed into specified broad areas in the expectation of practical discoveries. It provides the broad base of knowledge necessary for the solution of recognised practical problems;

> **Applied research** is original work undertaken primarily to acquire new knowledge with a specific application in view. It is undertaken either to determine possible uses for the findings of basic research or to determine new ways of achieving some specific and predetermined objectives;

> **Experimental development** is systematic work, using existing knowledge gained from research or practical experience, which is directed to producing new materials, products, devices, policies, behaviours or outlooks; to installing new processes, systems and services; or to improving substantially those already produced or installed.

# Appendix B – Research Engagement for Australia Steering Committee

The REA project was guided by a Steering Committee consisting of representatives from the four Learned Academies, Government and higher education sector, and included representation of the STEM, MHS and HASS disciplines.

> Peter Gray (ATSE), Chair
> Alan Finkel (ATSE)
> Tanya Monro (ATSE)
> Peter Laver (ATSE)
> Dom English (Dept of Education and Training)
> Lisa Schofield (Dept of Industry and Science)
> Lesley Johnson (AAH)
> John Fitzgerald (AAH)
> Steven Schwartz (CHASS)
> Terry Nolan (University of Melbourne)
> John Bell (ATSE)
> Paul Greenfield (ATSE)
> Virginia Hart (Dept of Education and Training)
> Aidan Byrne (ARC)
> Oliver Mayo (AAS)
> Margaret Sheil (University of Melbourne)
> Margaret Hartley (ATSE)
> Mark Western (ASSA)

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43      http://www.abs.gov.au/ausstats/abs@.nsf/Products/1297.0~2008~Main+Features~Chapter+2,Type+of+Activity?OpenDocument

# Appendix C – Detailed analysis of the REA results

During the REA Pilot, participating universities were invited to comment on the results calculated for their assessed UoEs. In order to compare the performance across different disciplines, national benchmarks were derived (Appendix G includes the calculation for benchmarks); a national average for the three REA Metrics was calculated in each two-digit FoR. The performance of participating universities was compared against this benchmark to assist with identifying strong performance on one or more of the metrics. This assisted with interpreting the results of the REA Pilot by situating each assessed UoE against a fixed value, normalised across each of the disciplines (i.e. a performance value of 2.0 in '01 – Mathematical Sciences' is equivalent to a performance of 2.0 in '02 – Physical Sciences').

Importantly, the REA Pilot confirmed the earlier findings outlined in the REA Proposal that REA measures aspects of research activity that are not rewarded under ERA – **Figures C1**, **C2** and **C3** illustrate this point. **Figure C1** shows the REA performance for M1[44] of each UoE assessed in the REA Pilot (i.e. each two-digit discipline in each participating university) compared against its corresponding ERA 2012 quality rating.

**Figure C1 REA M1 metric compared against ERA 2012 outcomes**
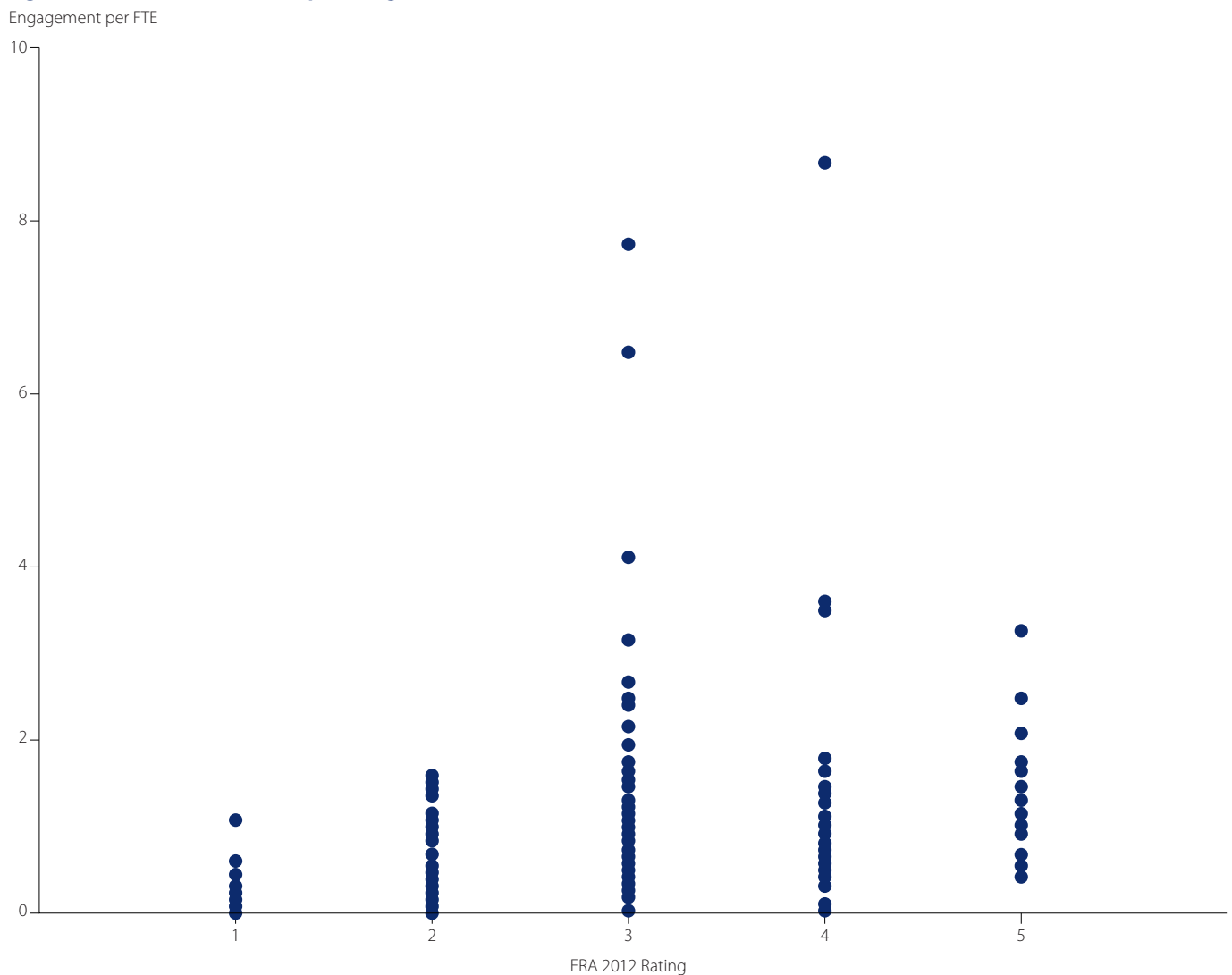
Engagement per FTE



44    As outlined, each UoE in Figures 2–4 is here compared against a national average, discipline specific average.

## Figure C2 REA M2 metric compared against ERA 2012 outcomes
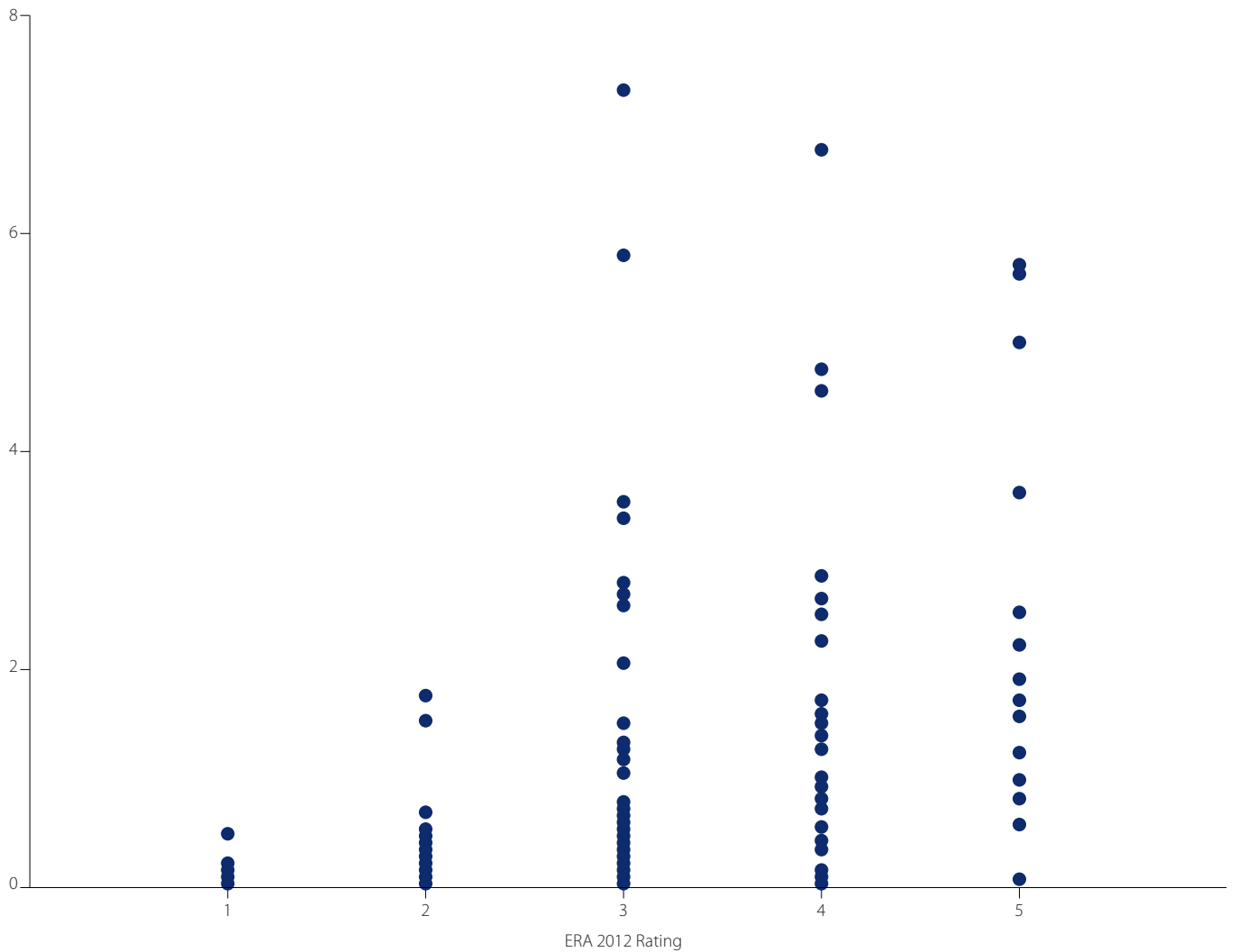
Share of national engagement activity



ERA 2012 Rating

**Figure C2** shows the REA performance for M2 of each UoE assessed in the REA Pilot compared against its corresponding ERA 2012 quality rating.

**Figure C3 REA M3 metric compared against ERA 2012 outcomes**
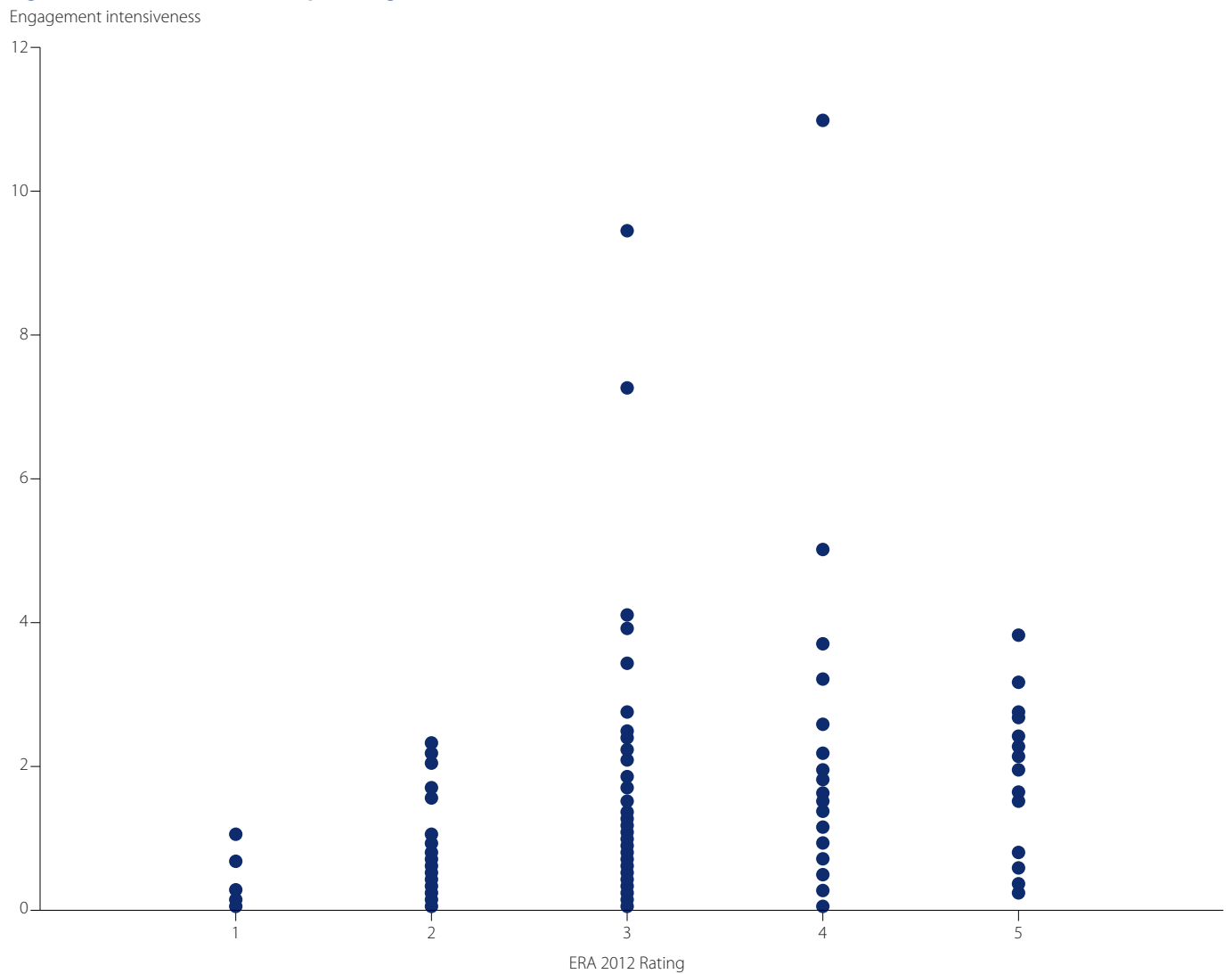
Engagement intensiveness



**Figure C3** shows the REA performance for M3 of each UoE assessed in the REA Pilot compared against its corresponding ERA 2012 quality rating.

In each of the figures above it is clear that there is a range of outstanding research engagement performance that is not reflected in an evaluation focussed on research publications and research excellence. For example, in **Figure C1** the highest six performances are included in UoEs that received either a '3' or '4' rating in ERA 2012. There is also clearly a large volume of research engagement activity that sits at the ERA '3' rating point. The same observation is true across the REA Metrics. The consistent variation between the two data points suggest that the activities being measured by the REA are often different to the activities being measured by a focus on research 'excellence'.

# Appendix D – Additional Commonwealth Schemes for inclusion in REA from ACGR

The following grants listed on the 2015 ACGR involve end-user contributions to university researchers. This list is not exhaustive and additional consultation is required to determine the non-Commonwealth schemes and programs that may be suitable.

**Department of Agriculture**
Carbon Farming Futures - Filling the Research Gap Rural Research and Development Corporations (RRDC)

**Cancer Australia**
Priority-driven Collaborative Cancer Research Scheme

**Department of Environment**
National Environmental Science Program (NESP)

**Australian Renewable Energy Agency (ARENA)**
Research and Development Program

# Appendix E – Recommended Enhancements to REA

The REA Pilot provided an opportunity to enhance and refine the REA Metrics and methodology in consultation with participating universities. Throughout the REA Pilot institutions were invited to comment on the REA Metrics with the aim of enhancing and refining them for future use. This section outlines the proposed enhancements, including:

## Enhancements to the REA methodology

> Incorporating additional financial inputs into the REA Metrics, such as Rural Research and Development Corporation (RRDC) income, relevant research extension income and additional consulting and contracting research income;
> Accounting for partner contributions to research funding;
> Enhancements to scale research engagement intensiveness; and
> Introducing an FTE threshold to ensure that the REA Metrics are stable.

## Enhancements to the REA approach

> Introducing small, explanatory vignettes to assist in interpreting the outcomes of the previous REA round and to provide examples of successful pathways to research engagement; and
> Developing additional contextual information that can assist in identifying strong relationships with research end-users and strong commercial applications.

## Enhancements to the REA methodology

### Incorporating additional financial inputs into the REA Metrics – RRDC income

The metrics used in the REA Pilot included the income universities receive through several of the HERDC Category 1 granting programs listed on the Australian Competitive Grants Register (ACGR). These were limited to major schemes administered by the ARC and the NHMRC (i.e. ARC Linkage, NHMRC Partnership and NHMRC Development programs). Throughout the REA Pilot further work has been undertaken to identify additional programs from the ACGR that include research income from end-users and which should therefore be included in REA.

In discussion with Commonwealth departments, agencies and organisations, a list of Commonwealth grants from the ACGR which are likely to be suitable for inclusion in the REA Metrics are listed in Appendix D. These are already collected by universities and submitted with appropriate FoR codes to ERA. This means that they could be incorporated into future REA deployment with no additional effort from universities.

One of the larger granting programs that was not included in the REA Pilot is the income from Rural Research and Development Corporations (RRDC). Particularly in the two-digit disciplines '05 – Environmental Sciences' and '07 – Agricultural and Veterinary Sciences', the funding provided by RRDCs is an important input providing a large proportion of the income supporting research engagement.

The funding provided by RRDCs for university researchers is comprised of contributions levied from industry, as well as matched dollars provided by the Commonwealth. In line with the REA methodology, it is important that the metrics account for the industry contributions only, disaggregating these from the

Commonwealth contributions. RRDCs are complex organisations that draw funding from a range of sources, with different funding pools often attached to specific activities. Moreover, each RRDC is unique in how it is funded – to what extent its funding is levied from industry, matched by Commonwealth or derived from other contributors – and the activities that this income can support.

The RRDCs are funded through industry and Government on the basis of levies on production charged by rural commodity, with a matching contribution from the Commonwealth up to 0.5 per cent of the gross value of production for the levied commodity on a rolling three-year average. Levy receipts can be subject to significant volatility year-on year depending on seasonal and market conditions. Each industry determines its rate of levy collection.

In consultation, the Council of Rural Research and Development Corporations has proposed to provide data against the following methodology in ongoing support of REA to disaggregate the contributions from industry.

### Method for assigning industry income from RRDCs

Levies are collected for R&D and non-R&D purposes, but not all commodities are subject to compulsory non-R&D levies. Analysis could be undertaken on an industry by industry basis to determine the split between these two levy types managed by the RDCs. The RDCs may also feature additional funding sources, including royalties, third party contributions and returns on investments.

Commonwealth funding is restricted to what is termed eligible research, development and extension (RD&E) expenditure, which represents for each RDC the amounts spent on research,

development, technology transfer and adoption, and related necessary administrative and corporate functions.

The Levies Revenue Service within the Department of Agriculture and Water Resources publishes an annual report to stakeholders outlining total levies collected and the amounts of Commonwealth matching funds. For the purpose of collection the R&D and non-R&D levies are generally combined, and the Department reports on levies by commodity or sector, and not by purpose.

Analysis by the Council of Rural Research and Development Corporations identifies that in the three years from 2012-13 to 2014-15 the average proportion of Commonwealth investment to eligible RD&E expenditure across all RRDCs was 42%, with the remainder coming from industry. The specific proportions for each RDC will vary depending on their particular mix of funding sources and levy rates. However, it would be reasonable to apply this percentage across a portfolio of investment from the RRDCs to get an indication of different funding sources and proportions.

In considering a balance between accuracy and implementation, it is likely that some accuracy will be compromised in deriving a relatively easy-to-implement approach. However, such a compromise is unlikely to have a large impact on REA – when either method is applied to the individual projects awarded to universities, the dollar differences will be small, and unlikely to significantly affect the overall performance of a university on the REA Metrics in a particular discipline. On balance, the proposed method and provision of data from the Council of Rural Research and Development Corporations strikes an acceptable balance.

Appendix H includes sample data on RRDC income available in the Department of Agriculture's Levies Revenue Services *Annual Stakeholder Reports* and publicly available data from the individual RRDCs through their annual reporting processes.

## Incorporating additional financial inputs into the REA Metrics – research extension income

The REA Metrics used in the REA Pilot employed the definition of research used in HERDC and ERA to limit the eligible income types that were included. The HERDC definition of research is:

*Research is defined as the creation of new knowledge and/ or the use of existing knowledge in a new and creative way so as to generate new concepts, methodologies and understandings. This could include synthesis and analysis of previous research to the extent that it leads to new and creative outcomes.*

*This definition of research is consistent with a broad notion of research and experimental development (R&D) as comprising of creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of humanity, culture and society, and the use of this stock of knowledge to devise new applications.*

*This definition of research encompasses pure and strategic basic research, applied research and experimental development. Applied research is original investigation undertaken to acquire new knowledge but directed towards a specific, practical aim or objective (including a client-driven purpose).*[45]

Using this definition means that a number of activities that are routinely performed by researchers, but which are not in and of themselves eligible for submission to HERDC and ERA, are likewise excluded from REA. In many cases this is a desirable outcome, and assists in keeping REA focused on research engagement and commercialisation income as a measure of the underlying activities and the institutional systems that support them. Throughout the course of the REA Pilot, however, several universities agreed that there are a range of revenue generating research engagement activities which are, a) part of an ongoing research program, and therefore, b) directly relate to research outputs (journal articles, books etc.) and/or research outcomes (commercialisation, patents etc.), but which were not considered in the REA Pilot because they do not meet the HERDC definition of research. **Box 1** provides an illustrative example from Griffith University and the University of Queensland – the *Parents under Pressure Program*.

In the case of PuP, income derived from the program takes the form of training and dissemination, and by this fact alone is not be eligible under the HERDC definition of research, and therefore will not have been included in the REA – this is in spite of the fact that it is derived from engagement activities of an active research program. The PuP income is one example of non-HERDC income that results from strong continuous engagement between research and industry; the PuP program feeds the evidence-based research while the continuity in research leads to a more effective program of benefit for the community. Another such example, from Griffith University, is provided in **Box 2**, and involves resource development for indigenous people.

In this case, the research-related income generated by Professor O'Faircheallaigh's activities as adviser or negotiator do not meet the eligibility criteria for HERDC submission, instead fitting into the category of 'research extension'. The income would therefore not be included in REA, in spite of providing an excellent example of research engagement generating income from research end-users, including strong engagement between university and industry with tangible, demonstrable societal benefits.

45      Department of Education and Training, *Higher Education Research Data Collection 2015 Specifications*.
        https://education.gov.au/higher-education-research-data-collection

## Box 1 Parents under Pressure (PuP) Program

Griffith University Professor of Clinical Psychology Sharon Dawe and Dr Paul Harnett from the University of Queensland developed the PuP program aiming to help parents facing adversity develop positive and secure relationships with their children. Professor Dawe and Dr Harnett have been working with students and fellow researchers for over 10 years on the development of the PuP model and have published a number of studies on the efficacy of the program. The team has also produced commissioned reports and policy documents.

The research behind the PuP program is based on the view that any treatment program should be based on evidence of effectiveness for the population with which it is being used. The researchers do a systematic evaluation of the effectiveness of the PuP program with multi-problem families including parents with opioid dependence, women leaving prison, families in child protection and indigenous families diverted from prison. The research on the efficacy of the program provides the evidence-base and leads to strong research engagement between the researchers and a number of agencies in need of adopting such structured programs, especially those working with multi-problem families.

The PuP program has been incorporated into the UK's National Society for the Prevention of Cruelty to Children (NSPCC) "All Babies Count" research and treatment initiatives with plans underway to have the program adopted across the UK. Before its launch in the UK, a number of Australian agencies involved in child protection had adopted the program.

The PuP program training and dissemination process earns substantial consultancy income while providing evidence for its evaluation within an implementation science perspective. The program trains therapists around Australia and the UK with funds from Mission Australia, Uniting Care West and NSPCC among others.

## Box 2 Resource Development and Indigenous Peoples

Griffith University Professor of Politics and Public Policy Ciaran O'Faircheallaigh has more than 60 publications and an international reputation for his research on the interaction between Indigenous peoples and large-scale resource development. His work has included ground-breaking empirical work in Africa, the South Pacific, Australia and Canada and has developed important conceptual insights relevant to Indigenous peoples globally. The main outcomes of his work relate to evaluation of agreements, the relationship between resource development and inequality in Indigenous society, and on the interface between international recognition of Indigenous rights and Indigenous mobilisation in domestic political arenas.

The success of Professor O'Faircheallaigh's research is based on its strong engagement with Indigenous organisations and communities for the negotiation of agreements with mining and oil and gas companies. He has acted as an adviser or negotiator for many of Australia's leading Aboriginal organizations including the Cape York, Northern, Central, Yamatji and others. Such activities are a clear extension of his research program which is based on strong engagement with industry (e.g. AusAid, Shell Australia Pty, Dept. of Community Safety and Autonomous Bougainville Government).

*Category 1–3 research income can only be included in a Higher Education Provider's (HEP) return if it meets all of the following principles:*

> *It must be for activities consistent with the definition of research.* ***This can include income derived from extension activities where these can be demonstrably identified as part of an ongoing research program***

> *It must be net receipted income, received in the reference year and recognised in a HEP's financial system as being related to the reference year*

> *It must be consistent with a HEP's audited financial statements*

> *It must only be counted once*

> *It must include any variations to research income previously reported*[46]

There is a strong case to be made that while these examples do not meet the HERDC definition of research, the income should be included in REA. As such, there is sense in expanding the definition of research income to include research-related extension activities where the income can be directly and verifiably tied back to an ongoing research program. For the purposes of REA, a simple addition to the HERDC research income categories may suffice, such as outlined below in **bold**:

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46    The following extract is taken from the HERDC 2015 Specification (*Section 4.1 general requirements*).
      https://docs.education.gov.au/system/files/doc/other/draft2015herdcspecifications.docx.

Although such income will already be captured by university research and finance systems, given they have not been eligible for HERDC or ERA purposes in the past, there would be effort involved for universities preparing the data for submission to REA, including assigning FoR codes and verifying the data. In addition, as these are not currently collected for ERA or HERDC purposes, they would need to be collected separately from these exercises if they were to be included in REA.[47]

## Incorporating additional financial inputs into the REA Metrics – other consulting and contracting income

Throughout the course of the REA Pilot it has been anecdotally estimated that there is an amount of relevant research income in institutions that is transacted outside of the universities' reporting mechanisms, and which will not be included in REA.[48] This may take the form of, for example, consulting undertaken by academic staff but conducted under individual ABNs etc. At present, given the small financial returns associated with the collection and submission of Category 2-3 income in the RBG allocations, there has been no effective incentive for universities to be comprehensive in the capture of these data. The figures reported to HERDC and ERA, and thus those used in REA, likely underestimate the volume of engagement and commercialisation income that is being generated by Australian universities. It is hoped that the increased focus on these income types provided by the introduction of REA would drive an increase in the capture and reporting of these income types in the future.

## Accounting for partner contributions to research funding

The intention of REA was to collect and include only income derived from non-Commonwealth sources. For example, where an ARC Linkage grant has been awarded, the amounts of Commonwealth (ARC-awarded) and non-Commonwealth (linkage partner contributions) are disaggregated, with only the latter included in the performance metrics. In most cases this presents no problem to universities (in most of the Category 1 funding schemes listed in Appendix D funding from the Commonwealth body and the partner funding body are delivered separately by the respective parties). In these cases the Commonwealth and non-Commonwealth contributions are reported under HERDC Categories 1, and either Category 2 or 3, respectively, depending on the sources.

There are some notable exceptions, however – the case of RRDCs has already been discussed in detail. In the case of Category 4 income, income derived from CRCs, universities already collect these data in a disaggregated form against the following sub-categories:

> Research income derived from Australian Government grants to CRCs;
> Research income derived from non-HEP members of CRCs; and
> Research income derived from external parties contributing to CRCs.

These sub-categories are submitted for HERDC, but not for ERA, and thus a number of institutions do not hold these in this disaggregated form against FoR codes. There would be a degree of work associated with universities assigning FoR codes to these sub-categories for the purposes of REA. However, the extent of this work is not prohibitive.

A more difficult case has been posed by ARC Linkage grants. The REA Proposal identified that as part of their HERDC submissions, different institutions were submitting the Commonwealth and non-Commonwealth contributions for this scheme differently – while some institutions recorded the Commonwealth contributions as Category 1 income and the Linkage partner contributions in Category 2 or Category 3 as appropriate, other institutions were reporting the entire value of the grant under Category 1 income.

In the most recent round of HERDC, the Department of Education and Training has issued advice to institutions on this, advising that both components should be reported against Category 1 income. For REA, it does not matter where the information is recorded, as long as the two income types are easily disaggregated into their component parts. However, for the sake of clarity it is proposed that keeping the two components separately reported across relevant HERDC income categories is the best approach. If the different components are conflated into a single reporting requirement, it is possible that universities will stop collecting the component parts separately in the future, which would affect the REA focus on non-Commonwealth contributions to research.

## Enhancements to scale engagement intensiveness

In the REA Pilot, the M3 metric was calculated using each university's 'Revenue for Ongoing Operations' as the denominator. This was intended to provide a measure of the relative focus of a university's engagement efforts in a given research discipline compared with other disciplines within the university. In the REA Pilot, the denominator included only a single year of revenue for each institution, whereas the corresponding numerator was taken across a three year period. In several cases, the calculated value was >1.0. While this figure is not inaccurate, it is potentially misleading i.e. it is not possible for an institution's engagement and commercialisation revenue to be >100 per cent of its annual research revenue. Further, if the metric includes one year of operating revenue compared with three years of research engagement income it may be skewed by significant performance in a single year. In this case, the metric will provide a skewed picture of the research engagement activities across the reference period, which may be dominated by activities in a single year, rather than sustained effort.

In order to address this simply, it is proposed that the denominator, like the numerator, take account of three years of revenue data in order to provide a more intuitive representation of

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the research engagement effort as a proportion of the university's overall research revenue. This scales the performance for time and provides a better representation of the sustained research engagement activity.

## Introducing an FTE threshold

In the REA Pilot, M1 was calculated for all UoEs that were evaluated under the corresponding ERA round. In ERA, eligibility to be included in the evaluation is based on a publication low volume threshold. In disciplines in the Humanities, Arts, Social Sciences and Information Technology, where peer review is employed as the main evaluation mechanism, the low volume threshold is equivalent to 50 research publications across a six year window, where books are weighted as 5 and all other output types as 1; in Scientific, Engineering and Medical disciplines where citation analysis is used in the evaluation, the low volume threshold is 50 journal articles across the six year reference period.

The focus of ERA is on evaluating research quality, and not researcher productivity and so there is no consideration given to how many researchers were involved in producing these research outputs. There are additional problems for presented in the ERA approach: first, staff data are coded separately from income and publication data. Second, for income data ERA places no restrictions on how many nor which FoR codes can be assigned. This stands in contrast to, for example, journal articles, which have restrictions imposed on which and how many FoR codes can be assigned to them. For ERA, this is not an issue, given that the focus of the evaluation is on research outputs, and there is no consideration of researcher productivity.

For REA, however, these issues pose two problems: first, in calculating M1, UoEs may be comprised of very low numbers of FTE (e.g. <1); second, because researchers are coded separately from their income it may be the case that a UoE has high dollars assigned to it but low FTE.

Implementing REA is likely to resolve these issues naturally over time as institutions pay more attention to coding FoRs to FTE based on where staff are employed and/or publishing, and where their income is earned. However, in order to overcome the problem, it is proposed that an additional low volume threshold, based on FTE, be applied to eligibility for REA. In order to derive this figure, analysis was conducted using anonymised data from the earlier REA Proposal to plot FTE distributions for each assessed UoE (**Figure E1**).

Modelling identified that of the 642 UoEs that were considered in the REA Proposal, only 8 had low FTE that were likely to skew the M1 metric (<5 FTE indicated in 'orange' in **Figure E1**). This equates to only 1 per cent of UoEs. Based on this analysis it is proposed that a UoE should contain at least 5 FTE to be evaluated in REA. Considered against the ERA publication threshold of 50 outputs, this seems to equate to a reasonable baseline for real productivity (around 1.7 outputs per person per year).[49] Introducing this FTE threshold balances the need for stable metrics with ease of implementation while remaining a comprehensive analysis.[50]

### Figure E1 Number of FTE per UoE from REA Proposal

Number of UoEs



Number of FTE

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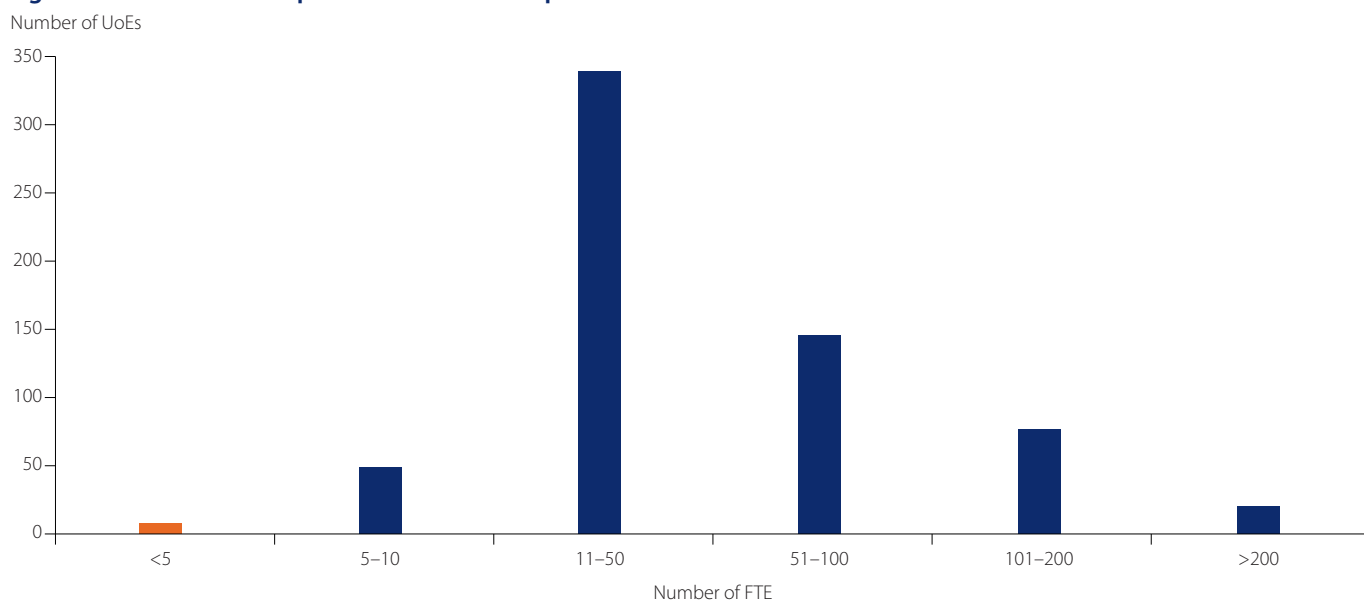
48    This matches with similar evidence in the UK, as outlined in Markus Perkmann et al. '*Accounting for universities' impact: using augmented data to measure academic engagement and commercialization by academic scientists*' (2015). *Research Evaluation* (advanced access).

49    This is derived as follows: (50 outputs/5FTE)/6 year publication window for ERA = 1.66 outputs.

50    This proposal should be read as working in conjunction with the proposal listed below to introduce limited case study vignettes as verification of REA outcomes.

# Enhancements to the REA approach

## Introducing small, explanatory vignettes

As outlined above, in ERA, and consequently in REA, there are no restrictions to which FoR codes financial data can be assigned. It is possible for institutions to code research income to FoRs that are separate from the researchers who have been awarded the income and from the outputs that are related to the income. This means that there is a pressing need to verify that performance in REA is related to real research engagement activities in a particular discipline within a university.

This should not take the form of an auditing exercise – detailed auditing of the financial activities of universities is undertaken as part of universities' ongoing tax obligations to State, Territory and Commonwealth governments; in addition, Category 1–4 income are independently audited as part of the annual HERDC collection. What is required, rather, is verification that the allocation of FoR codes to research engagement income used in REA corresponds to research activities in that discipline, and has not been strategically assigned to an FoR to artificially inflate performance.

## Box 3 – Energymiser®

Trains are a highly efficient form of transport, but consumption of fossil fuels leads to significant environmental pollution. Fuel consumption also has health implications for the general public: in 2012, the World Health Organisation declared diesel emissions to be carcinogenic. The NSW Office of Environment and Heritage has given a preliminary estimate of the health costs of locomotive emissions in Australia as $109M per annum. The Scheduling and Control Group (SCG) at the University of South Australia (UniSA) have worked on the development of on-board advice systems for train drivers for over three decades. Since 1998 the SCG has worked closely with Sydney-based company TTG Transportation Technology (TTGTT) to develop the on-board driver advice system *Energymiser®* for reducing fuel use.  In recent years, SNCF in France and Bombardier in Spain have also adopted the technology. Based on a solid research history extending back to the 1980s, SCG researchers have made substantial contributions to the development of a modern theory of optimal train control. In addition, they have played a major role in technology transfer by developing prototype software for driver advice units on both passenger and freight trains and for scheduling of trains on busy rail networks. The *Energymiser®* system has been developed in a series of specific projects between 1998 and 2012.

### Selected SCG train control publications

> P.G. Howlett and P.J. Pudney, *Energy-Efficient Train Control, Advances in Industrial Control*, Springer, London, 306 pages, 1995.
> P. Howlett, Optimal Strategies for the control of a train, *Automatica*, Vol 32 No 4 pp. 519 - 532, 1996.
> P. G. Howlett, The Optimal Control of a Train, *Annals of OR*, 98, pp. 65-87, 2000.
> P. G. Howlett, P. J. Pudney and I. P. Milroy, Energy-efficient train control, *Control Engineering Practice*, Vol. 2, No.2, pp. 193-200, 1994.
> P. G. Howlett and J. Cheng, A Note on the Calculation of Optimal Strategies for the Minimisation of Fuel Consumption in the Control of Trains, *IEEE Transactions on Automatic Control*, Vol. 38, No.11, pp.1730-1734, 1993.
> P. G. Howlett, and J. Cheng, Optimal Driving Strategies for a Train on a Track with Continuously Varying Gradient, *J.Aust.Math. Soc.*, Series B, (now *ANZIAM J.*), 38(3), pp. 388-411, 1997.
> P.J. Pudney and P. G. Howlett, Optimal Driving Strategies for a Train Journey with Speed Limits, *J. Aust. Math. Soc.*, Series B, (now *ANZIAM J.*), 36, pp. 38-49,1994.
> D Coleman, C Stoltz, PJ Pudney, PG Howlett, X Vu & AR Albrecht, Using simulation to assess the benefits of energy-efficient driving strategies, *Proceedings of the 9th Annual International Heavy Haul Conference*, Shanghai, 2009.
> P Howlett, P Pudney and X Vu, Local energy minimization in optimal train control, *Automatica*, vol. 45, no. 11, 2009, pp. 2692-2698.
> Albrecht, A.R., Howlett, P.G., Pudney, P.J. and Vu, X., Optimal train control: analysis of a new local optimization principle, *Proceedings of the American Control Conference 2011*, San Francisco, June 29-July 1, 1928-1933, 2011, http://ieeexplore.ieee.org/stamp/stamp.jsp? tp=&arnumber=5991057.

### Patents

> PG Howlett and PJ Pudney, 2010, *System for improving timekeeping and saving energy on long-haul trains*, US 7822491 B2.
> PJ Pudney & PG Howlett, 2010, *Scheduling method and system for rail networks*, CA 2526152.
> PJ Pudney & PG Howlett, 2008, *Scheduling method and system for rail networks*, US 7428452.
> PJ Pudney & PG Howlett, 2006, *System for improving timekeeping and saving energy on long-haul trains*, GB 2405016.
> PJ Pudney & PG Howlett, 2003, *System for improving timekeeping and saving energy on long-haul trains*, AUS 2003229097.
> AM Long, IP Milroy, BR Benjamin, GA Gelonese & PJ Pudney, 1993, *System for energy conservation on rail vehicles*, US 5239472.

In order to do this, it is proposed that universities provide a short written vignette or case study for a small sample of the UoEs evaluated under REA. To avoid creating a new reporting burden, it is proposed that this be restricted to a sample of the highest performing UoEs nationally in each discipline. In other words, where a university has performed exceptionally well in REA in a given discipline (perhaps in the top one or two universities for the discipline), a short vignette will be provided explaining how the income included in that FoR relates to underlying research engagement activities. An additional possibility would be for universities to submit vignettes in UoEs where they feel their REA results (i.e. based on research income) will not capture significant engagement activities.

An example is provided in **Box 3**, from The University of South Australia who recorded the highest performance in '01 – Mathematical Sciences' in the REA Pilot.

In this case, the simple explanatory vignette provided by the university easily verifies that the income being used to calculate REA reflects actual and ongoing research engagement programs in that FoR. This approach has the additional benefit of providing a set of case studies of exceptional research engagement for each FoR nationally that can be used for other purposes by government and stakeholders to demonstrate concrete public benefits that flow from university research.

To further limit the burden of producing these vignettes, one of the following existing mechanisms can be used to collect these case studies:

> *As part of the external auditing that universities already undertake for HERDC* – as an example, if REA was conducted in 2016, for each UoE where a university was amongst the highest performing for a given FoR, a case study vignette explaining the underlying research engagement activities would be requested as a part of their HERDC 2017 external financial auditing.

> *As part of the two-digit statements that universities already provide for ERA* – as an example, if REA was conducted in 2016, for each UoE where a university was amongst the highest performing for a given FoR, a case study vignette explaining the underlying research engagement activities would be requested as a part of the corresponding two-digit background statement in the 2018 ERA submission.

## Developing additional contextual information

The results of the REA Pilot indicate that research engagement can take different forms at different institutions, and that research engagement spans a continuum from research partner income to commercial and other applications. More often than not universities are involved in both activities, generating commercial revenue and deriving revenue from research partnerships with end-users. However, in some cases, the returns from commercialisation activities can far exceed the value of contracted research and consultancies, or vice-versa. It is useful to be able to identify cases where REA performance of a university in a particular discipline is driven in large part or entirely by one or the other engagement activities. As outlined in the introduction to this report, supporting the dual contribution of universities in meeting the needs of today's industries as well as developing the industries of the future is an important anticipated outcome of REA. To assist in identifying the different types of activity underlying REA performance, an additional contextual indicator is proposed: to enhance the information provided by the REA this indicator shows the proportional contribution of commercialisation and engagement income for each UoE.

**Table E1** includes example REA metrics calculated for University X in FoR '01 – Mathematical Sciences', '02 – Physical Sciences' and '03 – Chemical Sciences'. Displayed in the final two columns is a breakdown of the numerator i.e. the relative contribution of the Category 1–4 (Engagement income from research partners) and commercialisation income (Engagement income from commercialisation) to its performance in each FoR.

In **Table E1** there are two distinct performance profiles: in '01 – Mathematical Sciences' the university has earned mostly commercialisation income (89 per cent) and so the performance on the REA Metrics are driven primarily by engagement income derived from commercialisation activities; in contrast the performance in '03 – Chemical Sciences' is driven almost entirely by research engagement income from research partners (the relevant Category 1–4 inputs). This additional indicator provides useful context identifying the divergent performance profiles, and assists in interpreting the results of the REA Metrics. It usefully provides policy-makers, universities and other stakeholders (including potential end-users) the ability to identify the different underlying processes and structures that are being measured in REA performance.

### Table E1 Example REA Metrics for *University X* including new contextual indicator

| University X | M1 | M2 | M3 | Engagement income from research partners (%) | Engagement income from research commercialisation (%) |
|---|---|---|---|---|---|
| 01 – Mathematical Sciences | $813,177 | 22% | 4% | 11% | 89% |
| 02 – Physical Sciences | Not assessed | Not assessed | Not assessed | Not assessed | Not assessed |
| 03 – Chemical Science | $335,956 | 9% | 2% | 99% | 1% |

# Appendix F – Detailed REA Index ranking methodology

The following methodology is proposed to derive an REA Index from the three REA Metrics. It has been developed with the assistance of the Department of Education and Training, Economic and Market Analysis Branch (Research and Economic Group). The method is based on a common method of aggregating multi-dimensional statistics. This involves normalising the inputs (in a statistical sense) and deriving a weighted aggregate. The overall REA Index is based on a simple geometric mean of three normalised metrics M1, M2 and M3.

The basic process of calculating such an index can be summarised as follows

*Let A, B... be individual values of a metric for a UoE.*

**Step 1: Derive minimum and maximum values for the rankings**

*Amin = minimum (A1, A2... A41)*
*Amax = maximum (A1, A2... A41)*
*Etc., where 41 is the total number of universities.*

**Step 2: Create dimension indices (one for each REA metric) by scaling the data from 0-1**

*IA(i) = ( Ai - Amin ) / ( Amax - Amin )*
*where I runs across fields of research-institutions.*

**Step 3: Calculate the aggregate index (the REA Index)**

*The j-th root of the product of component indices, where j is the number of components, e.g. with three components it is the cubic root: REA_index (i) = jth root {   IAi * IBi * ... }*

## Examples of REA Index

### Rankings of universities

The calculated values of REA Index can be used to provide a ranking table of universities in each FoR. **Table F1** compares the sample rankings for FoR 11 and FoR 13. Only one institution (PBI) is in the top five universities across the two FoRs. Given the maximum value for each normalised REA metric, and therefore the overall REA Index is 1.00, the REA Index for institution GCK for FoR 11 (1.00) indicates that this institution is at the top in each of the individual dimensions unlike, for example, QZR in FoR 13 which is lagging in one or more of the dimensions despite topping the overall ranking for this FoR.

### Comparison of the index with the dimension metrics

The overall REA index can be plotted against each of the REA Metrics to provide an indication of the influence of each dimension (**Figures F1**–**F3**). For the example of FoR 11 the following points are clearly illustrated:

> The impact of each dimension is not reflected linearly in the index. For example, engagement per FT has an approximate exponential effect – small increments at lower levels only have a small impact.
> In each case, there is a group of leaders (four or five institutions) that score very highly on the REA Index and also have very high values for each of the REA Metrics.

**Table F1 Ranking of universities in FoR 11 and 13 (using all 41 institutions from REA Proposal)**

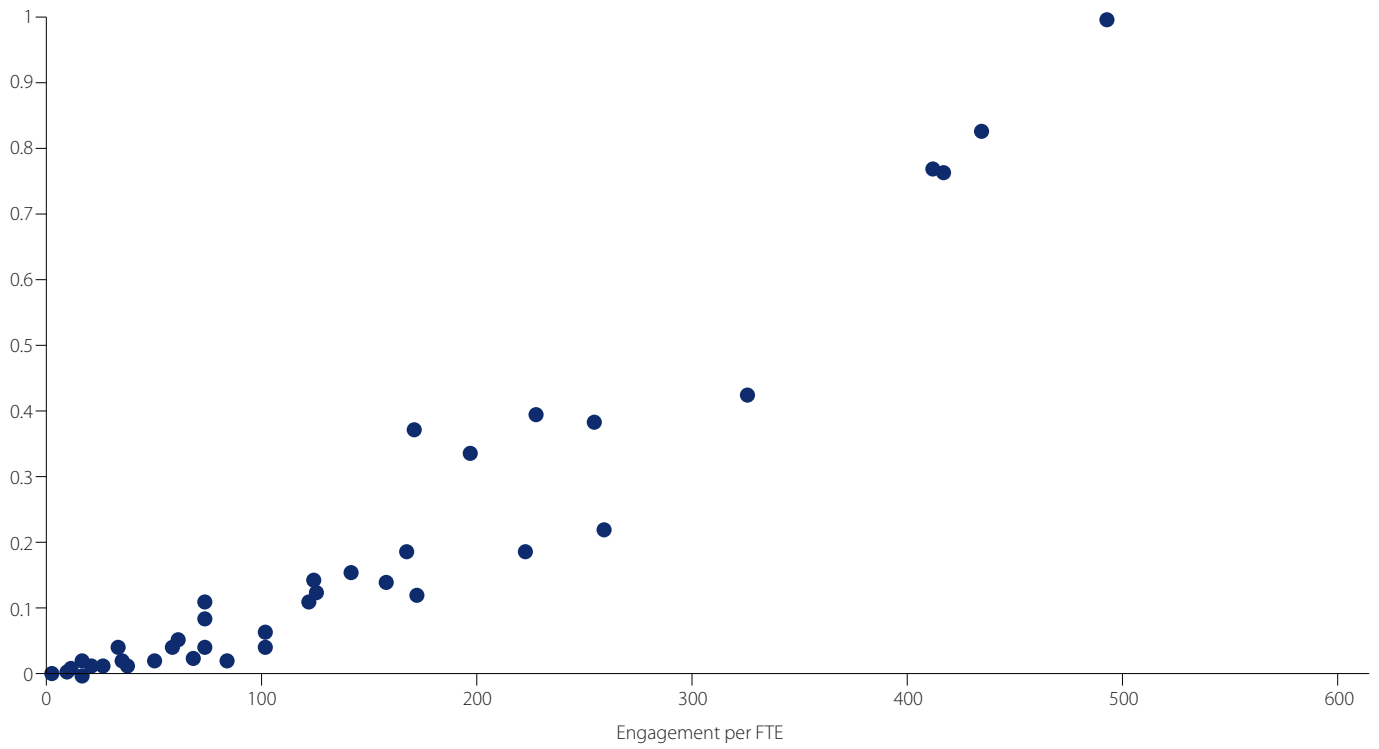| Rank | University | REA Index FoR 11 | Rank | University | REA Index FoR 13 |
|------|-----------|------------------|------|-----------|------------------|
| 1 | GCK | 1.000 | 1 | QZR | 0.842 |
| 2 | NCV | 0.828 | **2** | **PBI** | **0.708** |
| **3** | **PBI** | **0.773** | 3 | GSD | 0.639 |
| 4 | VFQ | 0.769 | 4 | CYK | 0.519 |
| 5 | SCJ | 0.426 | 5 | CSC | 0.434 |

**Figure F1 REA Index and M1**



**Figure F2 REA Index and M2**
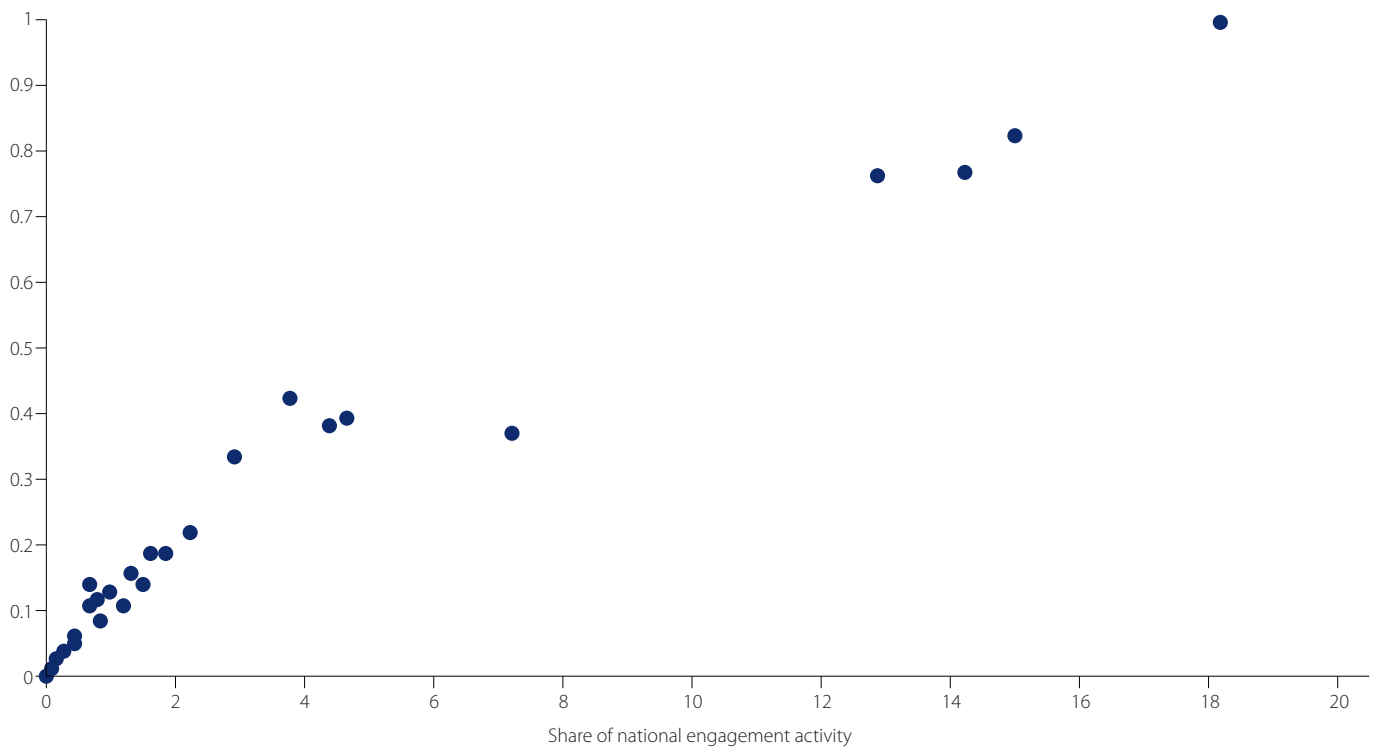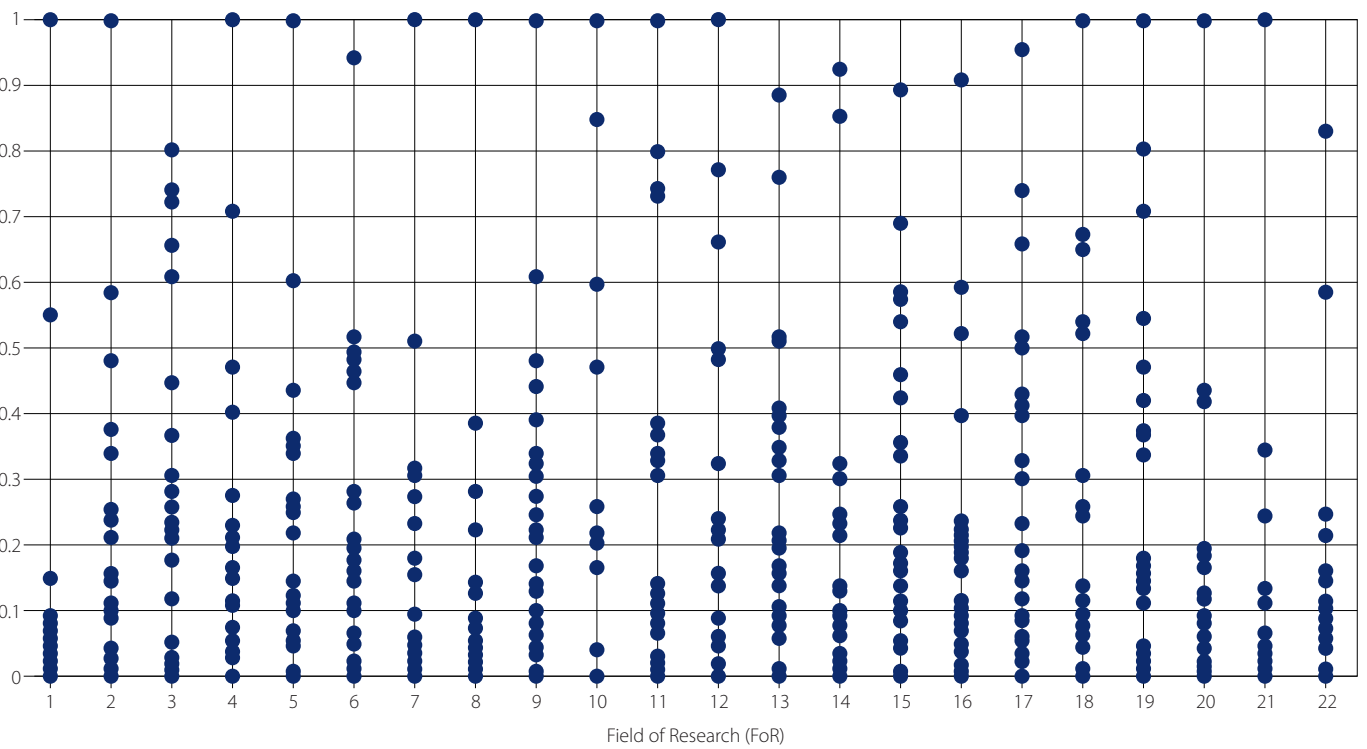
**Figure F3 REA Index and M3[51]**
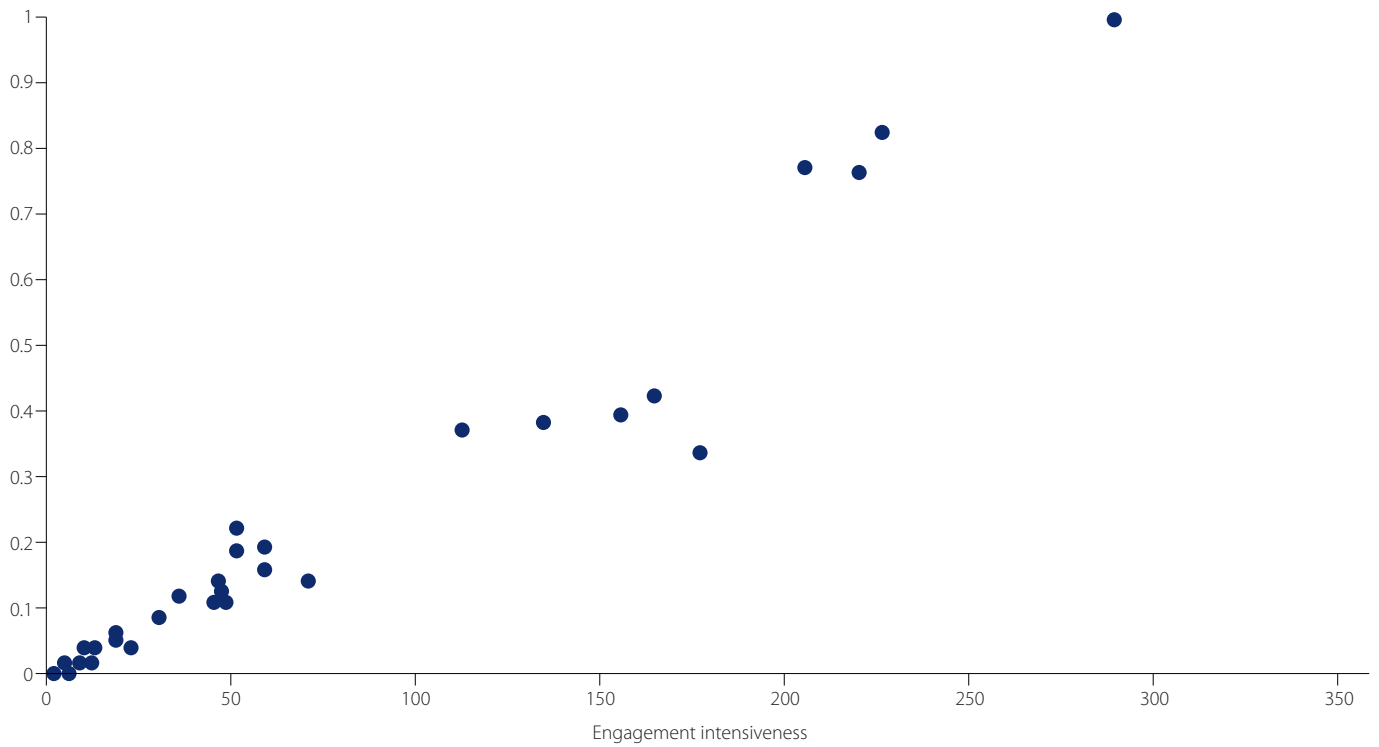


**Figure F4 REA Index derived from M2 and M3 only**

# Appendix G – Calculation of National Averages for the REA Pilot

The following national averages were used in the REA Pilot for comparison purposes. In each case, FoR refers to the national discipline as submitted to the ARC for ERA 2012.

## Engagement per FTE (M1)

$$\frac{\textit{Relevant Category 1}_{FoR} + \textit{Category 2}_{FoR} + \textit{Category 3}_{FoR} + \textit{Category 4}_{FoR} + \textit{Commercialisation income}_{FoR}}{\textit{FTE}_{FoR}}$$

## Share of National Engagement Activity (M2)

Calculation A:

$$\frac{\textit{Relevant Category 1}_{FoR} + \textit{Category 2}_{FoR} + \textit{Category 3}_{FoR} + \textit{Category 4}_{FoR} + \textit{Commercialisation income}_{FoR}}{\textit{Number of universities assessed ERA 2012}_{FoR}}$$

Calculation B:

$$\frac{\textit{Calculation A}_{FoR}}{\textit{Relevant Category 1}_{FoR} + \textit{Category 2}_{FoR} + \textit{Category 3}_{FoR} + \textit{Category 4}_{FoR} + \textit{Commercialisation income}_{FoR}}$$

## Engagement Intensiveness (M3)

$$\frac{\textit{Relevant Category 1}_{FoR} + \textit{Category 2}_{FoR} + \textit{Category 3}_{FoR} + \textit{Category 4}_{FoR} + \textit{Commercialisation income}_{FoR}}{\textit{Total revenue from continuing operations}_{All universities}[52]}$$

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[52]     Note this does not include the University of Divinity.

# Appendix H – RRDC Income Data

As a part of its annual reporting, the Department of Agriculture's Levies Revenue Services provides national figures for revenue and expenditure of the RRDCs. Annual Stakeholder Reports provide detailed information on this. **Table H1** shows the RRDCs' operational budget for the financial years 2012-13 and 2013-14. As indicated in the variance columns, annually the RRDCs can fluctuate significantly in terms of their operating budgets. It is therefore important to adjust for these yearly variations.

The final two (highlighted) rows of **Table H1** include amounts for 'Levy disbursed' and 'Commonwealth matching' for R&D across all the RRDCs. These two figures correspond to the income that has been distributed by the RRDCs which was levied from industry, and the amount of income distributed by the RRDCs from by Commonwealth matched funding. The average industry contribution to R&D is around 68 per cent of the total.

Additional publicly available data from individual RRDCs made available through their annual reporting processes demonstrates that the figure above matches better with some RRDCs than others. **Table H2** shows the annual reporting data from the Fisheries Research and Development Corporation (FRDC) for the year 2013-2014.

In this case, around 30 per cent of the R&D allocation through the FRDC in 2013-14 was derived from industry levies, and should be included in the REA Metrics.

Neither figure accounts for a complete dollar-for-dollar match of the levied amounts funding R&D for a range of reasons – for example, while the Commonwealth matching is provided explicitly for R&D (and extension) activities, levied components are used for a range of activities, including marketing and promotion and other activities specific to each RRDC (e.g. plant and animal health programs, residue testing and emergency plant pest and animal disease responses for levy paying industries etc.).

**Table H1 Rural Research and Development Corporations Operational Statement 2012–2014**

| Operating statement | 2012-13 ($) | 2013-14 ($) | Variance ($) | Variance (%) | 2014-15($)[53] |
|---|---|---|---|---|---|
| Revenues from government | 517,040 | 295,918 | (221,122) | –42.8% | 215,088 |
| Other revenue | – | 77,661 | 77,661 | 100.0% | – |
| Cost recovery charges | 5,246,899 | 5,027,023 | (219,876) | –4.2% | 5,075,600 |
| **Total revenue** | **5,763,939** | **5,400,602** | **(363,337)** | **–6.3%** | **5,290,688** |
| Employee expenses | 3,552,175 | 3,263,321 | (288,854) | –8.1% | 3,181,604 |
| Supplier expenses | 859,838 | 721,732 | (138,106) | –16.1°% | 615,596 |
| Other expenses | 5,073 | 11,863 | 6,790 | 133.8°% | 52,341 |
| Depreciation & amortisation | 157,896 | 177,271 | 19,375 | 12.3% | 173,270 |
| Departmental overheads | 1,289,620 | 1,211,141 | (78,479) | –6.1% | 1,267,877 |
| **Total expenses** | **5,864,602** | **5,385,328** | **(479,274)** | **–8.2%** | **5,290,688** |
| Net surplus / (deficit) | (100,663) | 15,274[54] | 115,937 | –115.2% | – |
| **Levy disbursed** | **427,720,799** | **467,245,363** | **39,524,564** | **9.2%** | **–** |
| **Commonwealth matching**[55] | **203,272,000** | **238,446,647** | **35,174,647** | **17.3%** | **–** |

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53      2014-15 reflects the estimated budget that was circulated to stakeholders in June 2014 and is subject to change throughout the year.

54      2013-14 surplus is a result of revenue associated with make good provisions from the Victorian office.

55      Commonwealth Matching for 2013-14 is an estimate based on actual disbursements and estimated claims.

**Table H2 FRDC Expenditure and income 2013-2014**[56]

| Expenditure | 2013-14 ($m) |
|---|---|
| **Total expenditure** | **27.56** |
| Total of R&D projects | 22.89 |
| R&D Program 1 (Environment) | 10.21 |
| R&D Program 2 (Industry) | 8.34 |
| R&D Program 3 (Communities) | 0.75 |
| R&D Program 4 (People development) | 1.94 |
| R&D Program 5 (Extension and adoption) | 1.65 |
| Management and accountability | 4.67 |
| **Total income to the FRDC** | **26.89** |
| Industry contributions | 8.17 |
| Maximum matchable (government) contribution | 5.99 |
| Actual government matched | 5.96 |
| Government unmatched | 11.97 |
| Total government contributions | 17.93 |
| Project funds from other parties | 0.49 |

56    FRDC 2013-2-14 Annual Report, http://frdc.com.au/about_frdc/corporate-documents/Pages/annual_rep.aspx

# List of abbreviations

ABS – Australian Bureau of Statistics

ACGR – Australian Competitive Grants Register

AIMS – Australian Institute of Marine Science

ANSTO – Australian Nuclear Science and Technology Organisation

ANZSRC – Australian and New Zealand Standard Research Classification

ARC – Australian Research Council

ARENA – Australian Renewable Energy Agency

ATSE – Australian Academy of Technology and Engineering

CRC – Co-operative Research Centre

CSIRO – Commonwealth Scientific and Industrial Research Organisation

ERA – Excellence in Research for Australia

FoR – Field of Research

FRDC – Fisheries Research and Development Corporation

FTE – Full Time Equivalent (staff)

HASS – Humanities and Social Sciences (disciplines)

HEIF – Higher Education Innovation Fund

HEP – Higher Education Provider

HERD – Higher Education Expenditure on R&D

HERDC – Higher Education Research Data Collection

JRE – Join Research Engagement

MHS – Medical and Health Sciences

NESP – National Environmental Science Program

NHMRC – National Health and Medical Research Council

OECD – Organisation for Economic Co-operation and Development

PuP – Parents under Pressure Program

R&D – Research and Development

RD&E – Research, Development and Extension

REA – Research Engagement for Australia

REF – Research Excellence Framework

RBG – Research Block Grants

RRDC – Rural Research and Development Corporation

SCG – Scheduling and Control Group

SCI – Science Citation Index

SRE – Sustainable Research Excellence

STEM – Science, Technology, Engineering and Medical (disciplines)

TTGTT – TTG Transportation Technology

UniSA – The University of South Australia

UoE – Unit of Evaluation (as per ERA)

# ATSE – In Brief

The Academy of Technology and Engineering (ATSE) is an independent, non-government organisation, promoting the development and adoption of existing and new technologies that will improve and sustain Australia's society and economy.

> ATSE consists of some 800 eminent Australian Fellows and was founded in 1976 to recognise and promote outstanding achievement of Australian scientists, engineers and technologists.

> ATSE provides a national forum for discussion and debate of critical issues about Australia's future, especially the impact of science, engineering and technology on quality of life.

> ATSE links Australia with leading international bodies and worldwide expertise in technology and engineering.

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