
COOPERATIVE RESEARCH CENTRES ASSOCIATION

# 2020-2021 Pre-budget Submission

**December 2019**

**Cooperative Research Centres Association 2020 – 2021 Pre-budget Submission**

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## Glossary

| | |
|---|---|
| ABC | Australian Broadcasting Corporation |
| ABS | Australian Bureau of Statistics |
| ARC | Australian Research Council |
| CRC Program | Cooperative Research Centres Program |
| CRC-P | Cooperative Research Centres Projects |
| CSIRO | Commonwealth Scientific and Industrial Research Organisation |
| DIIS | Department of Industry, Innovation and Science (Federal) |
| FTE | Full-Time Equivalent (a jobs count metric) |
| MFP | Multifactor Productivity |
| GDP | Gross Domestic Product |
| NHMRC | National Health and Medical Research Council |
| OECD | Organisation for Economic Cooperation and Development |
| PC | Productivity Commission |
| R&D | Research and Development |
| SME | Small and Medium Enterprise |

# Executive Summary

The Cooperative Research Centres (CRC) Program is a highly successful and internationally respected research model which has vastly improved the effectiveness and impact of Australia's overall research effort in its almost 30-year history. This has been achieved through funding industry-led collaborations and by linking researchers in both the public and private sectors with industry, government and the community.

The CRC Program is one of the most successful government innovation programs in the world, with recent reviews finding that the Program has provided a significant economic return on investment for the Australian community.

Yet, the Program achieves these results with only 1.7 per cent of all Federal Government funding on R&D between 2009-10 and 2019-20.[1] In addition, the redirection of CRC funding under the department's grant-to-project model, the CRC-Projects, has not been offset by additional funds to maintain the overall CRC Program meaning that funding has been, effectively, reduced in real terms.

In this submission, we argue for an increase in overall funding for the CRC Program. Specifically, the CRC Association proposes that funding for the CRC Program be increased by $200 million over the forward estimates (i.e. by $50 million per year), to reach a target level of $250 million per year from 2023-24. The additional level of funding would return the Program to long-run funding levels in real terms while making provision for the continued expansion of the CRC-Projects subprogram.

## Program strengths

A crucial strength of the CRC Program lies in its broad strategic aims: "*to improve the competitiveness, productivity and sustainability of Australian industries*". The Program focusses on backing Australia's key industrial strengths by fostering high-quality relevant research "*to solve industry-identified problems through industry-led and outcome-focused collaborative research partnerships between industry entities and research organisations*"(Andrews, 2019).[2]

Cooperative Research Centres are unique in that they assemble multidisciplinary teams from across research providers to address industry-driven research. A further defining characteristic of CRCs is collaboration and close interaction between researchers and end-users, with a focus upon research application and development towards use and commercialisation. The CRC Program is a tried and tested mechanism for facilitating research collaboration - it gives end-users a key role in planning the direction of the research and enables them to monitor and modify the research progress. This is a fundamental point of difference, and advantage, of the CRC model, compared with other publicly-funded research programs. Finally, the design of CRCs is unique among Australia's R&D programs in that it provides adequate time, flexibility, and industry direction to achieve significant impacts.

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[1] Department of Industry, Innovation and Science (2019). Over the 11 years 2009-10 to 2019-20, the CRC Program has received $1.772 billion (nominal) in funding out of $105.24 billion (nominal) in total Federal Government funding for R&D, or 1.68 per cent.

[2] Industry Research and Development (Cooperative Research Centres Program) Instrument 2019, Karen Andrews, Minister for Industry, Science and Technology (21 March 2019).

The CRC model combines the key ingredients for a successful research program. The combination of public, industry and academic participation/funding, directed to specific research objectives, and supported by strong governance, significantly increases the likelihood that the public investment will lead to a net economic benefit for the Australian community.

The Program has been repeatedly reviewed and analysed. Each review has found that the Program significantly adds to Australian innovation and contributes to the national GDP. It is vastly different from any other current or proposed research program. The timeframe, scale and most importantly, the fact that CRCs are market- and consumer-driven are critical to their success in delivering end results and impact.

According to the Department of Industry, Innovation and Science (2019), as one of their flagship programs, the CRC Program:

> *"help(s) to position Australia as a leader in the global innovation race".*

And according to the most recent comprehensive review of the CRC Program (Miles, 2015):

> *"Each of the above [referring to Howard Partners, Insight Economics, Professor O'Kane, Allen (2012)] confirmed the Program has been successful in bringing together industry and researchers, delivering products to market, training industry-ready PhD graduates and more broadly improving the lives of Australians. They also concluded that the Program provides a strong economic return for government investment" (Miles 2015).*

## CRC-Projects – a welcome innovation

In 2016, the CRC Program was expanded to include the second element of the program - CRC-Projects (CRC-Ps) in response to recommendations made by the 2015 Miles review. The CRC-Ps were designed to enable smaller but highly practical and significant industry-research collaborations. This expansion in the scope and ambition of the CRC Program has been widely welcomed by industry and was a very significant change in the almost 30-year history of the program.

Overall, the CRC Program bridges the potentially fatal 'collaboration gap' between our research community and business and industry users. That gap was clearly identified in the Performance Review of the Australian Innovation, Science and Research System (2006), namely the lack of knowledge transfer. As noted by the Review:

- Australia is poor at translating and commercialising its strong research base; and
- collaboration between the research and business community is weak.

Notwithstanding the success of the CRC-P model, in our view it is imperative that funding for the CRC Program should be reset to a level that can facilitate greater knowledge transfer and R&D between the research community and business. On present trends, the CRC-P component will continue to account for one-third of total CRC Program funding in the future, thus putting at risk the success of the overall Program.

## The importance of adequate public R&D funding

In the long-run, the most significant driver of rising living standards is productivity growth. GDP growth can be conceptualised as the sum of population growth, productivity growth and labour force participation growth. In per capita terms, what matters most is productivity growth.[3] For productivity growth what matters most is technological progress. And what matters most for technological progress is ongoing investment in R&D.

It is now widely accepted that direct support for R&D is a superior innovation policy to indirect methods of support. This policy was explicitly endorsed in the Ferris, Finkel and Fraser review of the R&D Tax Incentive (2016), which recommended a rebalancing of the R&D system favouring direct measures such as the CRC Program.

However, recent measures to contain the cost to the budget of the R&D Tax Incentive by capping payouts to SME's firms for losses have resulted in reductions of almost $4 billion over the past few years and has, in part, led to Australia's overall R&D investment level falling below that of many developed economies, such as the United States, China, South Korea and Japan.[4]

The Productivity Commission (2019), in its latest Productivity Bulletin, has identified the recent decline in Australia's investment in R&D as a troubling sign for the economy, noting:

> *"This is troubling because investment typically embodies new technologies, which complement people's skill development and innovation. This is especially so for investment in research and development, where capital stocks are now falling, and even more so, new investment* (Productivity Commission Bulletin, May 2019).

Improving collaboration between research institutions and industry can also significantly boost the effectiveness of R&D expenditure. Recent reports into Australia's innovation performance have highlighted the need for more such collaboration. For instance, the OECD found that:

> *"Strengthening incentives for collaborative research is essential. Research-business linkages would also be boosted by more effective programmes encouraging business to collaborate" (OECD, 2017).*

## Looking ahead

The recommendations of the Miles Review have been implemented, re-casting and greatly strengthening the governance processes around the CRC Program. Moreover, the CRC-P Program managers have introduced an even higher degree of flexibility and responsiveness to the overall CRC Program. However, the introduction of the CRC-Projects has negatively impacted other parts of the overall program by drawing scarce funds away from other worthwhile industry proposals. At a time when Australia's overall public funding levels for science and innovation research are very low by

[3] This is the "3-P's" framework developed by the Australian Treasury Department. Labour force participation growth's contribution to GDP is, essentially, negligible because the long-run increase in female labour force participation has almost peaked, and is now fully offset by a decline in average hours worked.
[4] https://www.smh.com.au/politics/federal/not-a-good-sign-australia-s-r-and-d-investment-slips-against-developed-peers-20190826-p52kvd.html.

international standards, this funding shortfall must be addressed.

In recent policy statements, the Australian Government has recognised that further and ongoing collaboration between industry and research providers is vital to improving our innovation, performance and competitiveness. The CRC Program is fit-for-purpose to promote greater collaboration between Australia's research institutions and industry.

Looking ahead, given the relatively low public funding for R&D and the Australian Government's in-principle support to lift Australia's investment in innovation:

> *the CRC Association proposes that the government commit to supporting the CRC Program with an additional **$200 million** in budgetary funding over the forward estimates (from 2020-21 to 2023-24).*

The CRC Association's proposal would involve an equal increase (in nominal terms) of $50 million per year over the forward estimates. In effect, this increase in funding would raise the baseline of the CRC Program to $250 million per annum on an on-going basis from 2023-24.

In our view, this proposal is consistent with:

- current government innovation policy;
- the recommendations of the Ferris, Finkel and Fraser review; and
- world's best practice in terms of government support for R&D being provided through grant-based programs to complement indirect (tax-based) measures.

To put this proposed increase in context, the current level of funding for the CRC Program is $184 million (in 2019-20), almost 10 per cent below the long-run average level of $201 million (in 2019-20 dollars). Further, if funding for the Program were set at its long-run average level *as a percentage of GDP* (being 0.0156% since 1991-92), funding would have been $304 million in 2018-19.[5]

In our view, $201 million per year (in 2019-20 dollars) would be the minimum budgetary allocation to ensure the continued success of the program and to counteract, at least in part, the crowding-out effect of the CRC-P Program. To build on this success and achieve more success, working towards maintaining funding in real terms as a percentage of GDP would be desirable. However, we recognise the difficulties associated with targeting budgetary funding as a percentage of GDP.

We, therefore, submit that funding should be increased towards a target level of around $250 million per year from 2023-2024 (see Table E1 below).

Beyond funding support, a further requirement for the delivery of effective applied R&D is transparent and stable governance. In this respect, the CRC Program is exemplary in its structure and performance and this gives all stakeholders confidence to invest.

Based on an analysis of industry responses to previous CRC opportunities, we estimate that $200

[5] The most recent annual GDP figure is for 2018-19.

million of new government investment would attract contributions by industry partners of some $122 million cash, $183 million of FTE value and $178 million of non-staff in-kind contributions. This submission, therefore, requests an expansion of the program, of $200 million over four years, as set out in the table below.

**Table E1 The cost to the government of recommended CRC Program funding**

| CRC Program funding | 2019-2020 ($M) | 2020-2021 ($M) | 2021-2022 ($M) | 2022-2023 ($M) | 2023-2024 ($M) |
|---|---|---|---|---|---|
| Current CRC Program commitment (to 2022-23), and proposed (2023-24) | 184.150 | 187.356 | 192.239 | 191.223 | 200.000 |
| Additional funding (proposed) | - | 50.000 | 50.000 | 50.000 | 50.000 |
| Proposed total CRC Program commitment | - | 237.356 | 242.239 | 241.239 | 250.000 |

Source: 2019-20 Commonwealth Budget Papers and CRC Association analysis.

# 1. Introduction

The CRC Association is pleased to submit this 2020-21 Pre-Budget submission on behalf of our full, supporting and associate members.[6]

## 1.1 Current Australian Government funding for R&D

The Australian Government will invest $9.6 billion in research and development (R&D) in 2019-20. This includes $7.6 billion in direct support for R&D, including in our national research organisations such as the CSIRO. The government is also investing an additional $488 million in other science, research and innovation-related programs and activities. In addition to direct budgetary assistance, the Australian Government (and State Governments) offer a number of concessional tax measures that support R&D (most notably the R&D Tax Incentive, which is valued at $2.8 billion).

In 2019-20, out of the total annual investment from the Australian Government in R&D, $184 million has been allocated to the CRC Program, or approximately 1.9 per cent. The average allocation to the CRC Program since 2009-10 has been 1.7 per cent of total Australian Government R&D investment.

It is clear that the Australian Government recognises that R&D drives economic growth, raises living standards and delivers broad social benefits.

The Minister for Industry, Science and Technology Karen Andrews has said that:

> *"That is why I am working with my Ministerial colleagues to continue making smart and strategic investments that will support our researchers and businesses to undertake the cutting-edge R&D that leads to new treatments for disease, advanced technologies for industries such as manufacturing to thrive, and the development of new products and services that we can export to the world." (Media Release 19 September 2019).*

## 1.2 The Cooperative Research Centres Program

The Cooperative Research Centres (CRC) Program was established to address a significant gap in business-research collaboration in the Australian innovation system – the fact that there is often a disconnect between research and development (R&D) undertaken at Australia's research institutions and the application of that research by business and industry. As such, the CRC Program aims to improve the competitiveness, productivity and sustainability of Australian industries, especially where Australia has a competitive strength, and in line with government priorities.

The strength of the CRC Program lies in its broader framework that draws on a diverse range of organisations to maximise the potential for innovative outcomes. Through the Program, pioneering technologies, products and services have been developed, new and global markets are being accessed, and businesses have been able to increase their income, competitiveness and productivity.

[6] All 23 current CRCs are full members of the CRC Association, while 30 Australian Universities, including all members of the research intensive Go 8 and ATN networks are supporting members.

## 1.3 About this submission

This submission describes the CRC Program, its rationale and applications, to support the case for adequate funding of this important R&D initiative.

The submission is structured as follows:

- Section 2 describes the CRC Program, and how the program operates;
- Section 3 identifies the ways in which the CRC Program contributes to Australia's growth and prosperity;
- Section 4 outlines recent governance reforms to the CRC Program;
- Section 5 presents the funding history for the Program; and
- Section 6 presents our findings and recommendations.

Supporting information is contained in the annexures to this submission:

- Annexure A provides a brief overview of some recent achievements of the CRC Program;
- Annexure B lists the numbers of CRC-P applications received and funded;
- Annexure C provides a list of government reviews of the CRC Program;
- Annexure D lists impact/economic studies of the CRC Program;
- Annexure D summarises the findings of the impact and economic studies that have been undertaken of the CRC Program.

# 2. The Cooperative Research Centres Program

The following provides a brief overview of the CRC Program, its key mechanisms, and governance framework.

## 2.1 Origin and objectives

The CRC Program is a significant component of the Australian Government's Research and Development System. The CRC Program was officially launched in 1990 and the first CRCs were established in 1991. Since the program's inception, the government has committed $4.8 billion in funding to support the establishment of 225 CRCs and 111 CRC-Ps, leading to a total of 320 collaborations funded over the program's lifetime. In addition, there has been a total of over $14.9 billion in cash and in-kind contributions from partners.[7]

The CRC Program was established to address a significant gap in business-research collaboration in the Australian innovation system. It aims to improve the competitiveness, productivity and sustainability of industries, especially where Australia has a competitive strength, and in line with government priorities. The Program is a competitive, merit-based one that supports industry-led collaborations to address major challenges facing Australia, many of which are global challenges.

The CRC Program has been mission-driven since the outset. CRCs operate as companies with a mission to achieve major impacts. Through the CRC Program, innovative technologies, products and services have been developed, new and global markets are being accessed, and businesses have been able to increase their income, competitiveness and productivity. The CRC Program is one of the most successful government innovation programs in the world, yet it accounts for less than two per cent of all Federal Government spending on R&D.

## 2.2 Program components and funding sources

The CRC Program consists of two elements:

- Cooperative Research Centres (CRCs) are funded by grants, which support medium to long-term industry-led collaborations, of up to 10 years; and
- Cooperative Research Centres Projects (CRC-Ps) are funded by grants, which support short-term, industry-led collaborative research, leading to the development of important new technologies, products and services, up to three years (Box 2.1).

[7] Department of Industry, Innovation and Science, Factsheet, Cooperative Research Centres Program, Business.gov.au.

Box 2.1 Cooperative Research Centres Projects (CRC-P) Grants

CRC-P Grants provide funding for short-term research collaborations where the research objective is to develop new technology, a product or service. The Australian Government provides 'matched funding' of between $100,000 and $3 million and grants are for up to three years.

The research collaboration must be industry-led, with at least two Australian industry organisations, including at least one small to medium-sized enterprise, and one Australian research organisation (such as a university partner).

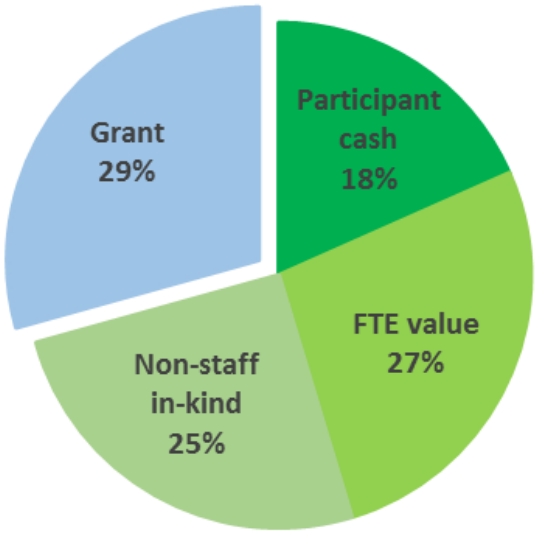
Funding could be used to support new research, proof of concept activities, pre-commercialisation of research outcomes, industry-focused education and training activities, conferences, workshops, symposia related to the joint research, and information sharing and communications related to the research.

Applications for CRC-P funding are generally called twice a year.

Source: https://www.business.gov.au/Grants-and-Programs/Cooperative-Research-Centres-Projects-CRCP-Grants

Government investment in the CRC Program is highly leveraged. Overall, around 30 per cent of CRC Program funding is contributed from government grants, 27 per cent of the total contribution is in the form of labour, 25 per cent is non-staff in-kind funding (such as for computers and lab space), and 18 per cent is industry participant cash (Figure 2-1).

### Figure 2-1 Contributions to CRCs




Source: CRC Program.

## 2.3 Participating organisations

The CRC Program encourages participation from a diverse range of organisations to maximise the potential for innovative outcomes. Participating organisations include:

- universities and research institutions;
- businesses from multinational corporations to small and medium enterprises;
- governments at all levels;
- international partners; and
- not-for-profit organisations, industry and community associations.

Furthermore, the Program encourages and facilitates small and medium enterprise (SME) participation in collaborative research.

## 2.4 Governance

The level of governance in a CRC is a major strength. Innovation and Science Australia and its CRC Advisory Committee provide strategic oversight of the program. These organisations also provide advice to the Minister on matters, including the assessment of applications, and recommendations in relation to selection processes. Each CRC's activities are actively managed by the CRC management team and the CRC Board to maximise national benefits. CRCs are allowed a significant degree of flexibility to enable terminating, redirecting or accelerating projects in a way that is not part of the culture of most other programs.

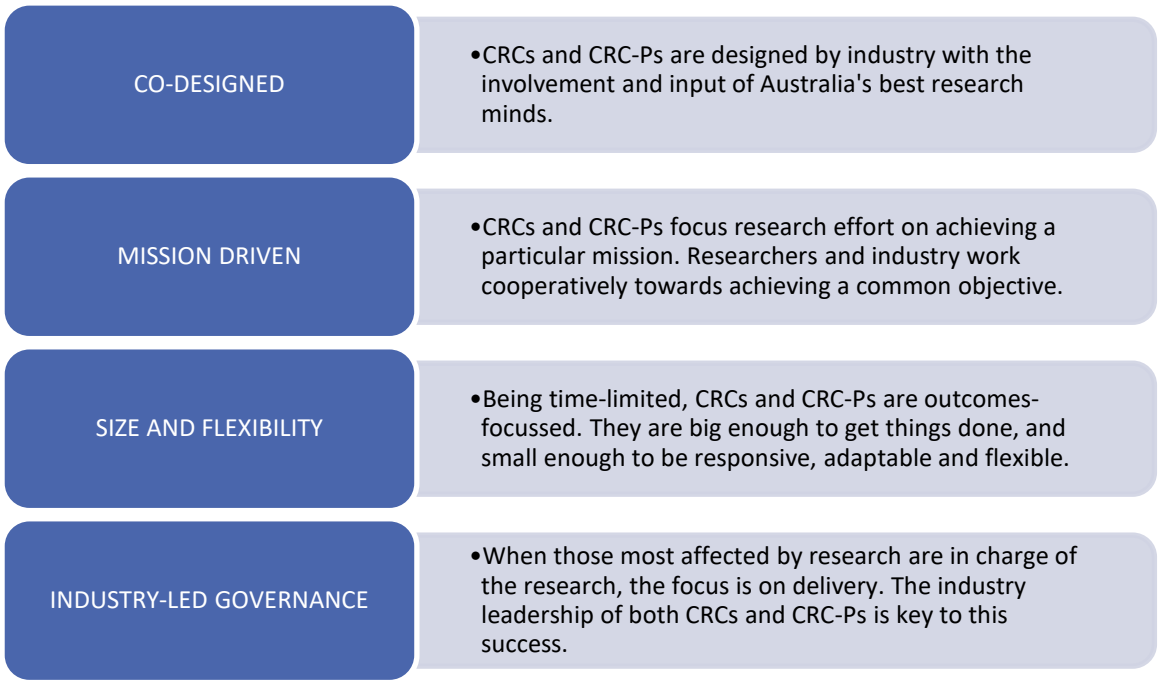
Strong governance processes have enabled the CRC Program to continue to perform well. This is reflected in the numerous studies and reviews which have been undertaken and which have documented a strong performance.[8] The design of CRCs is unique among Australia's R&D Programs in that they provide sufficient time, flexibility, and direction to achieve significant impacts. The stability of the Commonwealth grant confers flexibility to follow successful work with additional investment within a CRC structure (Figure 2-2).

Overall, the CRC model combines the key ingredients for a highly successful research program. The combination of public, industry and researcher participation/funding, driven by specific research objectives, and strong governance, demonstrably leads to very large economic benefits for the Australian community.

The CRC Association was established shortly after the CRC Program as a voluntary membership organisation. It provides advice and resources for CRCs and CRC-Ps to ensure they learn from the experiences of others.

[8] See Annexure C for a full list of reviews of the Program.

**Figure 2-2 The keys to success for CRCs and CRC-Ps**




Source: CRC Association (2019).

# 3. The CRC Program's contribution to Australia

In this section, we describe the rationale for the CRC Program, and how this program contributes to Australia's economic growth and prosperity.

## 3.1 Investment in intellectual capital, and economic & productivity growth

The fundamental role that R&D plays in supporting economic growth is well understood. One of the underlying tenets of the 'New Growth Theory' literature (Arrow 1962, Romer 1990) is that the accumulation of knowledge, innovation or human capital is the principal source of technological change and productivity growth (Elsnari and Fox, 2014). Given that the resources that are available to us are finite, productivity growth is the key source of sustained economic growth.

GDP growth can be thought about as the sum of productivity growth, population growth and labour force participation growth.[9] In per capita terms, population growth falls out of this equation. In Australia, labour force participation growth has had a negligible impact on GDP growth in recent years because the long-term trend increase in female labour force participation (which is now slowing) has been negated in recent years by a trend decline in average hours worked.

There are different ways of improving productivity, but the most significant is by growing what is broadly referred to as 'knowledge' or 'intellectual' capital, which is created by new technology, skills, R&D, and more efficient services and production processes. These positive effects are amplified by so-called 'spillovers', as new knowledge is rarely confined to any one firm or even industry and indeed can often be used repeatedly and simultaneously at little extra cost to users (Industry Commission, 1995).

Businesses typically undertake applied research – original work undertaken to acquire knowledge with a specific application – and experimental development – systematic work, using existing knowledge gained from R&D or practical experience directed to producing new or improved products or processes (Industry Commission, 1994). R&D performed by the business sector results in new goods and services, a higher quality of output, and new production processes. Many empirical studies confirm the positive impact of business R&D on productivity (Elnasri and Fox, 2014). An OECD analysis of the long-term relationship between productivity growth and business R&D from 1980 to 1998, for instance, found that (Guellec and De La Potterie, 2002):

- business R&D has a positive and significant impact on multi-factor productivity (MFP, the combined productivity of capital and labour), indicating that there are substantial spillovers from business R&D such that the return to the economy as a whole is larger than the private return;
- the impact of business R&D on MFP has been growing over time since 1980, confirming the increasing importance of technological change for economic growth in the knowledge-based

[9] This is the so-called "3-P's" framework developed by the Australian Treasury Department.

economy; and

- the impact of business R&D on MFP is larger in countries where R&D intensity (the ratio of business R&D to business GDP) is higher, suggesting that there are increasing returns are at work.

## 3.2 Recent trends in R&D expenditure

Recent R&D expenditure in Australia has fallen relative to key OECD metrics.[10] According to the Australian Bureau of Statistics (ABS):

- total expenditure on R&D dropped from 1.88 per cent of GDP in 2015-16 to 1.79 per cent in 2017-18, a level well below the OECD average for developed nations of 2.37 per cent; and
- business expenditure on R&D also fell from one per cent of GDP in 2015-16 to 0.9 per cent in 2017-18, well below the OECD average of 1.49 per cent.

Australia nonetheless has an excellent research infrastructure and a high degree of research quality in science and engineering. At the same time, the transfer of knowledge remains an ongoing challenge:

- Australia is poor at translating and commercialising its strong research base;
- collaboration between the research and business community is weak; and
- the mobility of people between academic and business careers is low.

Hence, while there are a number of industrial sectors that stand out in terms of the innovations that they bring to market (for instance, mining and financial services), the vast majority of innovation introduced by Australian businesses is not novel and relies on the adoption and adaptation of existing technology and knowledge.[11] The conclusion drawn by Innovation and Science Australia is that the Innovation, Science and Research System is failing to capitalise on its above-average performance in knowledge creation:

> *Transferring and applying that knowledge into radical innovation is what generates greater impact and higher rewards to business, the economy, and broader society.*

These findings are echoed in a recent comparative study by the United States Studies Centre's Innovation and Entrepreneurship Program on behalf of the NSW Government (Scott-Kemnis, 2018):

[10] https://www.theaustralian.com.au/higher-education/rd-spending-drops-below-oecd-average/news-story/86f921d3a51522e7efc19f5105732b53, accessed on 29 November 2019.
[11] Nonetheless, the adoption and adaptation of technology developed elsewhere is beneficial to economic growth, as the Productivity Commission demonstrated in its numerous Inquiry Reports and Research Papers on ICT use. See, for example: https://www.pc.gov.au/research/completed/ict-use/ictuse.pdf.

*Australia has a research system that produces high-quality research — but mostly in organisations weakly connected to industry. Hence, levels of collaboration between research and business for innovation are low.*

As a result, the linkages between industry and research institutions are weak compared to other OECD countries:

- Australian industry's collaboration with higher education and research institutions ranked the lowest of 27 countries in the OECD, both for large businesses and for SMEs;
- only 6.2 per cent of large, innovating firms in Australia collaborate with universities, while in Germany 40 per cent collaborate and in Finland the figure is 69 per cent;
- in 2013-14, only 2.3 per cent of business sector expenditure on R&D was directed to higher education organisations and one per cent to government research organisations;
- in 2014-15, only three per cent of Australian businesses reported sourcing their ideas for innovation from higher education institutions, suggesting that Australian businesses are largely disconnected from the publicly funded research sector; and
- the proportion of innovation-active SMEs that collaborate with universities or public sector organisations for innovation is 4.1 per cent — a third of the OECD average and the second-lowest in the OECD.

## 3.3 What does the Productivity Commission say?

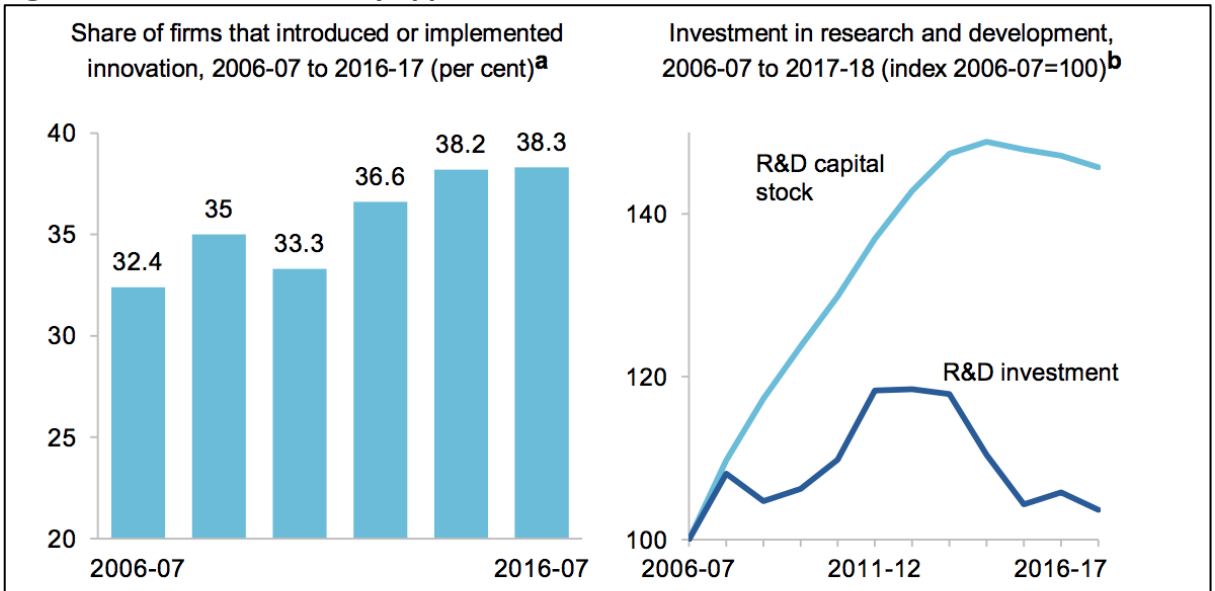
The Productivity Commission (2019), in its latest Productivity Bulletin, has identified the recent decline in Australia's capital growth, which is currently significantly lower than the historical norm. For example, economy-wide capital growth has increased by less than two per cent per year over the past three years, which is well below the historical average of four per cent per year from 1974-75 to 2017-18.

The Productivity Commission noted:

*"This is troubling because investment typically embodies new technologies, which complement people's skill development and innovation. This is especially so for investment in research and development, where capital stocks are now falling, and even more so, new investment (figure 3.1). Growth in R&D capital formation is even more subdued than capital formation generally, so that the R&D investment share of total investment has also fallen. The share of businesses that are innovators — which goes beyond R&D spending — is no longer growing."*

The figure below relates to the Productivity Commission's quote (above). It is clear from the graph (left-side) that innovative activity has stalled. And the chart (right-side) demonstrates the relationship between investment and the capital stock.

**Figure 3-1 Innovative activity appears to have stalled**




a Data for innovation were not available for 2017-18. b Chain volume estimates.

*Sources*: ABS (*Innovation in Australian Business*, various issues, Cat. no. 8158.0, table 1); and ABS (2018, *Australian System of National Accounts, 2017-18*, Cat. no. 5204.0, table 56).

Source: Productivity Bulletin, May 2019 (Productivity Commission).

Recent budgetary pressures have led the Australian Government to undertake measures to contain the cost to the tax system of the indirect R&D measures by capping payouts for losses, and almost $4 billion has been cut from the R&D Tax Incentive. According to an OECD index of R&D investment by government, these cuts have driven Australia's overall R&D investment to below that of Europe, China, the United States, South Korea and Japan.[12]

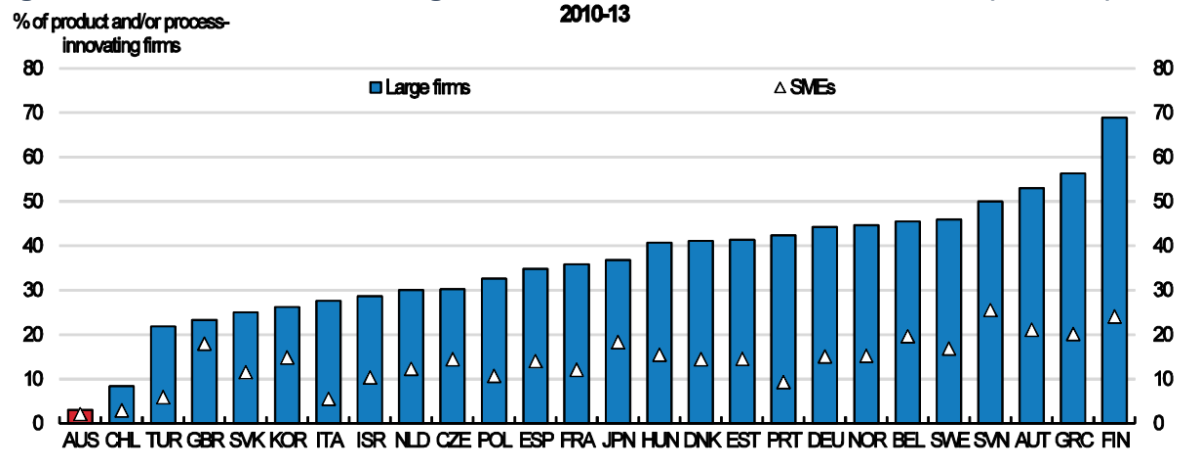
In relation to the R&D Tax Incentive, we note that the Ferris, Finkel and Fraser review of the R&D Tax Incentive (2016), recommended a rebalancing of the R&D system favouring direct measures such as the CRC Program.

## 3.4 The importance of collaboration

Collaboration between research institutions and industry can act as a catalysing agent for greater R&D output for a given level of investment. Indeed, recent reports into Australia's innovation performance have highlighted the need to improve the current low level of collaboration between universities and business in Australia. The figure below, taken from a 2017 OECD report into Australia's R&D performance, shows our comparatively poor performance relative to our peers (Figure 3-2). At less than five per cent, Australia is an outlier among its OECD peers in terms of business-university collaboration.

[12] https://www.smh.com.au/politics/federal/not-a-good-sign-australia-s-r-and-d-investment-slips-against-developed-peers-20190826-p52kvd.html: accessed 19 November 2019.

**Figure 3-2 Firms collaborating on innovation with research institution, (2010-13)**




Source: OCED (2017).

As Figure 3.2 (above) highlights, there is significant scope for Australia to improve its rate of university-business collaboration. The OECD found that:

> *"Strengthening incentives for collaborative research is essential. A simpler funding system for university research that provides sharper and more transparent incentives for research partnerships is important in this regard. Research-business linkages would also be boosted by more effective programmes encouraging business to collaborate, measures promoting greater mobility of researchers between the two sectors, and steps to ensure that intellectual property arrangements are not a barrier to knowledge" (OECD, 2017).*

The Australian Parliament has also recognised the problem with a lack of collaboration between research institutions and business. Recently, the Senate Economics Reference Committee, when examining Australia's Innovation System (2015) recommended:

> *"The committee recommends that the Australian Government, as part of its long-term innovation strategy, includes policy options to address the structural and strategic barriers that inhibit innovation, including: measures to enhance collaboration and the free flow of knowledge between the university system and the private sector; increasing the size of the research and development workforce employed in industry; and ensuring that public funding to support science, research and innovation is long-term, predictable and secure*" (Recommendation 3, December 2015).

The recent Performance Review of the Australian Innovation, Science and Research System (Commonwealth of Australia, 2016) highlighted, in general terms, the disconnect between Australia's research effort and the transfer of that knowledge to industry. However, the report also identified the CRC Program as a program that supports collaboration.

As a program that promotes user-driven, collaborative public-private research, the CRC Program plays a vital role in furthering Australia's research and innovation agenda and improving industry-university collaboration. In our view, the CRC Program, perhaps better than any other Federal Government supported R&D program, addresses the issue of low collaboration highlighted above.

## 3.5 CRC Program performance

The CRC Program has been the stand-out policy instrument for encouraging high quality, medium- to long-term collaborative research in Australia (Miles Review, 2015). The Program objectives seek to link advances in science and technology with their eventual application in industry and in other areas of national interest, so as to maximise the benefits from investment in publicly funded research.

The CRC Program has been the subject of five specific reviews, a number of broader reviews of business programs and three specific impact studies. Broadly speaking, the recommendations flowing from the reviews and resulting changes to the program centred on a shift away from basic research, and a greater focus on translating research outcomes to achieve commercialisation.[13]

### 3.5.1 Miles Review (2015)

The Miles Review in 2015 summarised previous assessments of the CRC Program:

> *Each of the above [referring to Howard Partners, Insight Economics, Professor O'Kane, and Allen Consulting] confirmed the programme has been successful in bringing together industry and researchers, delivering products to market, training industry-ready PhD graduates and more broadly improving the lives of Australians. They also concluded that the programme provides a strong economic return for government investment.*

The Miles Review also recommended some changes, including a refocus of the CRC program to better align it with the government's policy objectives, which have since been implemented. In particular, the Miles Review recommended that the CRC Program should be structured into two streams of activity – traditional CRCs to support medium- to long-term industry-led collaborations, and CRC projects (CRC-Ps) to support short-term, industry-led research. Overall, Miles recommended a renewed focus on solving industry problems and encouraging industry to take the lead in collaborative research and development activities by:

- improving the competitiveness, productivity and sustainability of Australian industries;
- establishing and supporting industry-led and outcome-focused collaborative research partnerships between industry and research organisations; and
- conducting high-quality research to solve industry problems.

While the focus of the CRC Program has shifted over time, in line with government policy, the key performance metrics identified in the Miles Review provide a useful overview of the Program (Table 3-1).

[13] Annexure C provides an overview of the outcomes of the reviews that have been conducted of the CRC Program.

**Table 3-1 Key facts and figures about the CRC Program (Inception to 2015)**

| Metric | Outcome |
|---|---|
| **Industry demand for CRC Program** | - 744 applications submitted since inception<br>- Between 2008 and 2014, 66 per cent of industry applicants were new, and 47 per cent of participants in CRC applications were new to the Program |
| **Industry participation in CRCs** | - 209 CRCs funded since 1991<br>- 1,905 participants, including 1,277 industry participants<br>- Broad mix of industry participants, including large (328), medium (272), small (262), 32 industry associations, and 383 unspecified |
| **Patents filed and held by CRCs** | - 1,936 patent applications and 12,684 patents held |
| **Publications** | - 35,434 journal articles<br>- 42,838 end user reports |
| **PhD graduates and employment** | - Average CRC has 21.5 active PhD students<br>- 3,600 PhD graduates<br>- 1,755 PhD graduates employed with industry organisations between 2003-04 and 2012-13 |

Source: Miles Review (2015).

### 3.5.2 Allen Consulting Group (2012)

An impact study of the CRC Program by the Allen Consulting Group (2012) correspondingly identified very significant economic, environmental and social impacts between 1991 and 2017:

- almost $14.5 billion of direct economic impacts are estimated to have accrued from CRC produced technologies, products and processes; and
- the CRC Program generated a net benefit to the economy of $7.5 billion over this period, or around 0.03 percentage points of additional GDP growth per annum.

This is a significant finding. While most economic models will find positive economic *impacts* of programs via additional investment and spending, to measure a *benefit* in terms of additional GDP (an overall measure of Australian production), accounting for the 'costs' of those programs, highlights the high quality of the CRC Program.

The study also identified significant environmental benefits, in relation to the land, ecosystems, pollutants, natural resources, plants, animals and biodiversity, as well as social benefits.

Overall, Allen Consulting concluded that **the CRC Program has generated a net economic impact to the community that has exceeded its costs by a factor of 3:1.** Each dollar the government invests in the program is boosted by more than three dollars of co-investment by CRC partners. The report

cited examples such as:

- the sale of products manufactured in Australia using technology developed by the CRC for Polymers, increasing sales revenue by $25 million;
- the CRC for High Integrity Australian Pork delivering cost savings of $14 million annually since 2010 through advances in grain technology and feed efficiency; and
- the HEARing CRC technology used by Cochlear adding value of approximately $120 million in 2012.

Almost $14.5 billion of direct economic impacts are estimated to have accrued from CRC produced technologies, products, and processes since 1991 (Table 3-2). This includes $8.6 billion of impacts estimated to have occurred from 1991 to 2012, and a further $5.9 billion of imminent impacts estimated to have occurred over the five years between 2012 and 2017.

**Table 3-2 Direct economic benefits of the CRC Program by sector (2012 $ millions)**

| Sector | 1991-2012 ($m) | 2013-2017 ($m) | Average annual ($m) | Total current value ($m) |
|---|---|---|---|---|
| Agriculture | 3,649 | 2,501 | 237 | 6,150 |
| Services | 3,125 | 2,558 | 219 | 5,683 |
| Mining | 1,177 | 372 | 60 | 1,549 |
| Manufacturing | 628 | 440 | 41 | 1,068 |
| Total | 8,580 | 5,872 | 556 | 14,452 |

Source: The Allen Consulting Group, 2012.

# 4. Recent governance reforms

Like many government policies and programs, the CRC Program has evolved and improved over time. As a result, the Program has a sharpened focus on research and innovation activities that are of direct relevance to Australian industry. Given the weak links that exist between businesses and research institutions in Australia overall (section 3), there is a strong case to be made that funding for the program should be such that projects that have been identified as offering real potential for value-added can proceed.

The CRC Program is highly regarded and recognised internationally as an extremely successful government innovation program. The Program has been extensively studied, reviewed, and refined to achieve its objectives: "*enhancing Australia's wellbeing through the development of sustained, user-driven, collaborative public-private research centres that achieve high levels of outcomes in adoption and commercialisation*". The CRC Program also fills an identified gap, in that it supports bridging the disconnect between academia and industry.

In commissioning the 2015 Miles Review of the CRC Program, the Department of Industry asked: "whether this business-research collaboration program is the best use of Commonwealth funds to effectively, efficiently and appropriately support businesses and researchers to work together to develop and transition to Australia's industries of the future".[14]

Miles (2015) concluded that there is no doubt that the business-research collaboration is, indeed, highly effective. The Review made a total of 18 recommendations, all of which were accepted by the government. The Review found that the CRC Program was valuable and effective and that the program should also continue its vital role in training the next generation of researchers and entrepreneurs, and inspiring cultural change in industry and research so that innovation and collaboration become the norm.

A key recommendation (recommendation six) of the 2017 Innovation and Science Australia 2030 roadmap was to encourage investment in research programs "*that directly support activity in areas of competitive strength and strategic priority*," including CRCs and CRC Projects, *"in order to adopt as the top priority of innovation policy the reversal of the current decline in business expenditure on research and development*" (Innovation and Science Australia, 2017).

Support for the CRC Program has accordingly come from a broad range of stakeholders:

- Peter Yates, Chairman of the Australian Science Media Centre and recipient of the Australian Academy of Science Medal for 2019 has praised the CRCs for being successful and advocated, in an interview on ABC Radio (19th October 2019), for a "hundred times" more CRCs.
- Bill Ferris AC, former chairman of Innovation and Science Australia, suggested recently that

[14] https://consult.industry.gov.au/crc-programme-review/crc-programme-review: accessed 25 November 2019.

to encourage industry-research collaboration - where Australia lags significantly, the CRC program, as well as the short-term CRC-Ps, should be expanded, and called for a quadrupled commitment to the program.[15] He believes the Morrison government should favour programs like CRCs as "*innovation drives productivity which drives GDP growth and living standards*".[16] He cites the Vision CRC (one of the first CRCs which developed breakthrough contact lens technology, the O2Optix and Night & Day(r) contact lenses)[17] which has generated $350 million of royalties to date.[18]

- Yvette Waddell of the Vision CRC states that only one in five project proposals are currently receiving funding while she believes that this should be closer to one in three.[19]

Stakeholder feedback has also been positive, emphasising the importance of the Program in supporting industry-focused research and encouraging collaboration between industry and research in Australia. The Program was described by some stakeholders as the 'glue' in Australian industry-research collaboration, and by others as a unique avenue for industry to identify and solve its research challenges. The Program was also noted as an important funding source for universities to enable long-term and complex industry-focused research through collaboration (Miles, 2015). Insight Economics, in its economic impact study, found that the CRC Program was delivering very clear net benefits for Australian economic welfare and that for each dollar invested in the CRC Program, Australian gross domestic product was cumulatively $1.16 higher than it would otherwise have been (Insight Economics, 2006). Professor O'Kane noted the Program as iconic and highly influential, having been copied by several countries (O'Kane, 2008).

[15] https://www.afr.com/politics/bill-ferris-laments-weak-business-rd-feds-innovation-cold-shoulder-20181104-h17h70; accessed 29 November 2019.
[16] https://www.afr.com/politics/federal/budget-a-stunning-lost-opportunity-says-bill-ferris-20190403-p51aci; accessed 29 November 2019.
[17] https://en.wikipedia.org/wiki/Cooperative_Research_Centre#cite_note-9; accessed 29 November 2019.
[18] https://www.afr.com/technology/swap-failing-r-and-d-incentive-for-proven-grants-20190725-p52aup; accessed 29 November 2019.
[19] https://www.afr.com/technology/swap-failing-r-and-d-incentive-for-proven-grants-20190725-p52aup; accessed 29 November 2019.

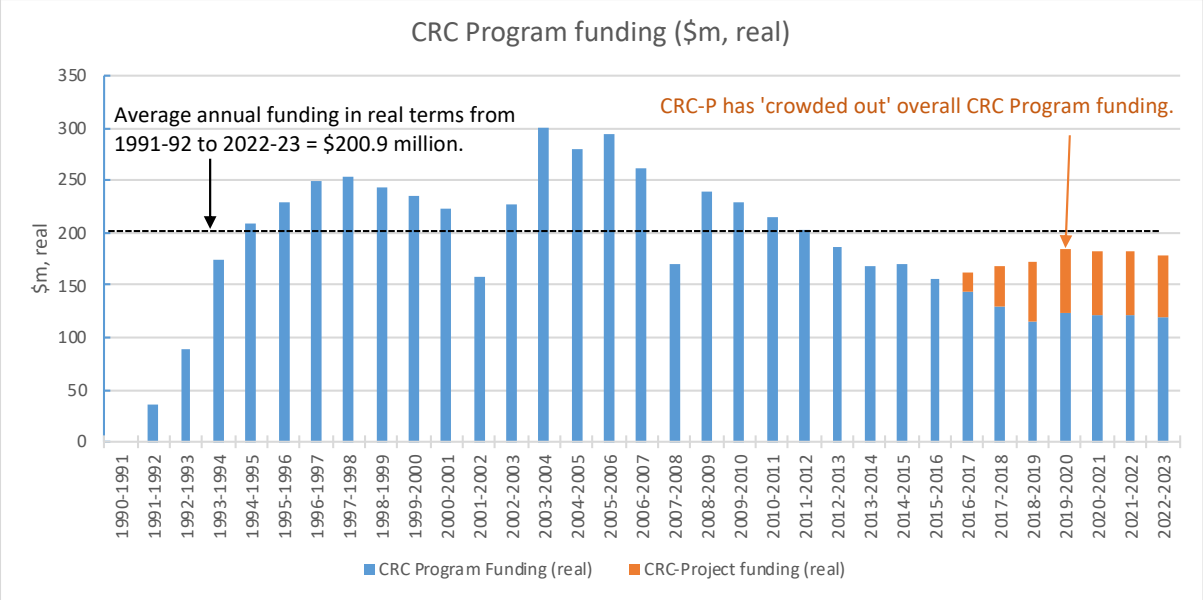
# 5. CRC Program funding

## 5.1 Funding levels since 1991-92

Notwithstanding recent increases in funding for the CRC Program since 2015-16, funding levels have remained below long-run average levels of $201 million per year (in real terms) since 2011-12.[20] Figure 5-1 (below) highlights the highly cyclical nature of CRC Program funding over time. Annual funding for the Program 'ramped-up' in the 1990s before declining in the early 2000's. The Program then reached peak funding levels in the mid-2000s before steadily declining to reach a post ramp-up low of just over $150 million (in real terms) in 2015-16.

Since 2015-16, Program funding has been increased to reach $184 million in 2019-20. However, an estimated one-third of total Program funding ($61.6 million) has been allocated to CRC-Projects.

**Figure 5-1 CRC Expenditure 1991-92 to 2022-23, (real $2019-20)**




Source: Federal Government budget papers and Tulipwood Economics analysis. Note: For simplicity, CRC-P funding has been allocated equally across project years.

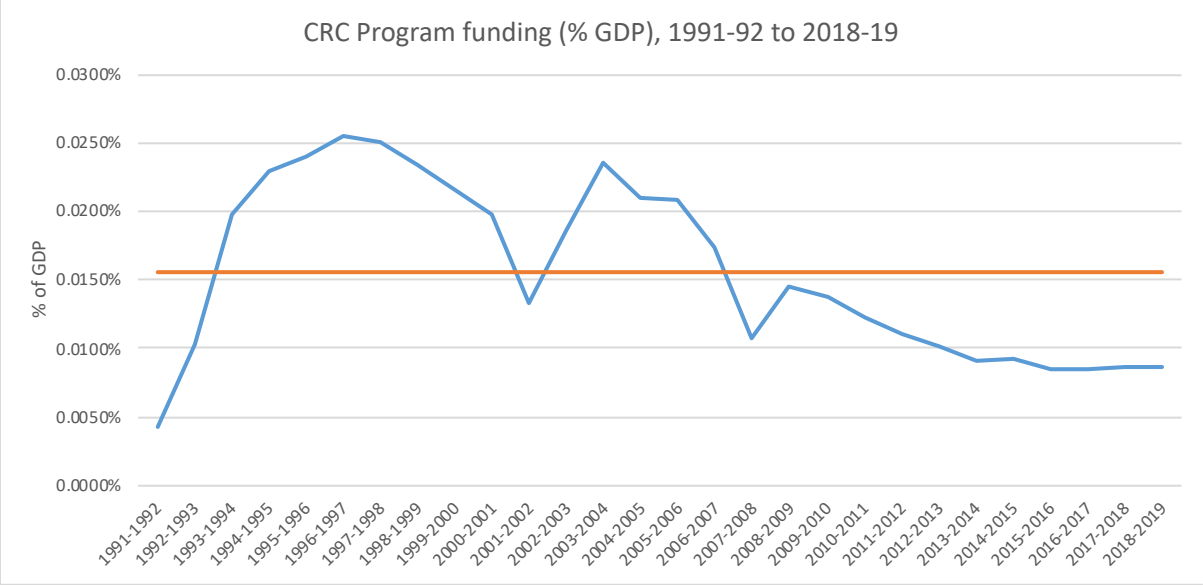
## 5.2 Relative funding levels

When CRC Program funding is measured as a percentage of GDP, the level of budgetary support peaked in the mid-1990s and again in the early 2000s. Since then funding as a proportion of GDP has steadily declined except for an uptick in 2008-09 driven more by the fact that GDP growth stalled in the GFC (Figure 5-2). Given the relationship between public R&D investment and economic growth (see Section 3), it is important to at least monitor overall (and components of) R&D investment as a proportion of overall GDP. In Australia's case, as we demonstrate in Section 3, both the overall levels

[20] Figures have been adjusted for inflation (at 2.5%) into 2019-20 dollars.

of investment in R&D and the level of investment in the CRC Program, as a proportion of GDP, have declined in recent years.

**Figure 5-2 CRC Program funding as a proportion of GDP, 1991-92 to 2018-19**




Source: Department of Industry, Innovation and Science (2019) and Tulipwood Economics analysis.

In nominal terms, the level of investment in the CRC Program in 2019-20 ($184.33 million) is barely above its level in 2009-10 ($178.87 million). Based on the 2019-20 Science, Research and Innovation (SRI) Budget Tables produced by the Department of Industry, Innovation and Science, we compared funding for a number of publicly-funded research programs between the years 2009-10 and 2019-20.[21]

These other Australian Government programs with similar R&D objectives have enjoyed increased funding over the decade ranging between two per cent (Australian Research Council) and 4.5 per cent per year (Rural R&D Corporations). The National Health and Medical Research Council funding has increased by 2.43 per cent per year over the decade, and Research Block Grants have increased by 3.74 per cent over the decade (Figure 5-3).

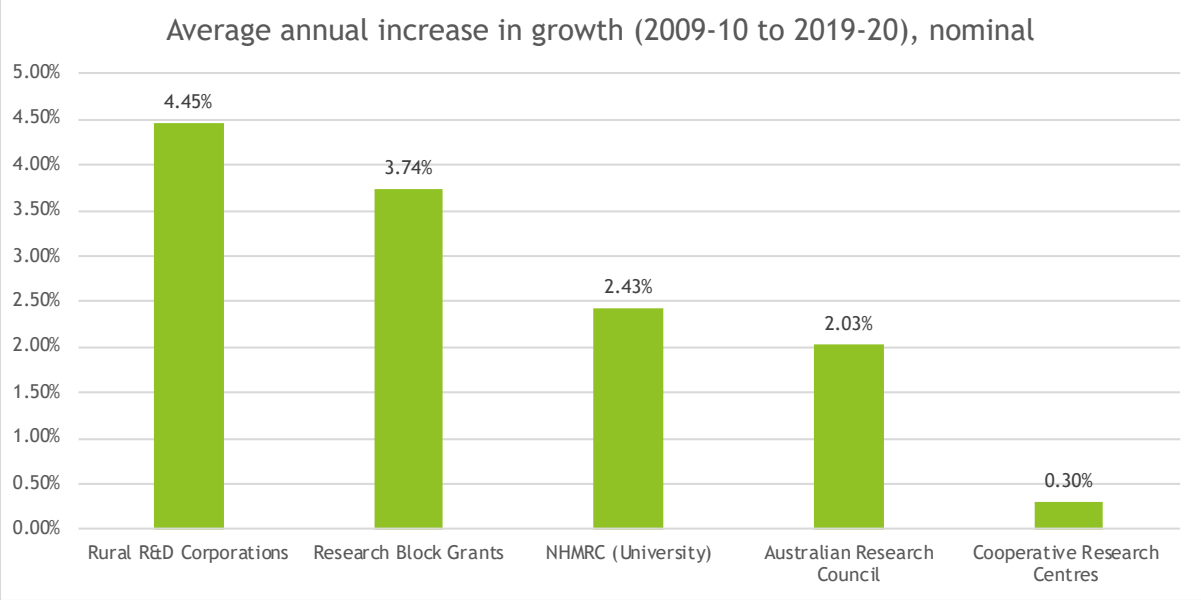
Moreover, compared to 2009-10, CRC Program funding has declined as a percentage of total Australian Government investment in R&D, from 2.2% to 2.9%.

In terms of total funding provided over the decade (in nominal terms), CRC's have received $1.8 billion, while Rural R&D Corporations have received $2.9 billion, Research Block Grants ($18.9 billion), NHMRC ($6.7 billion), and ARC ($8.6 billion). While these comparator programs are generally much larger programs with often very broad research objectives, there is a stark difference in funding levels when the Australian Government should focus on industry-led direct measures of R&D

[21] See: https://www.industry.gov.au/data-and-publications/science-research-and-innovation-sri-budget-tables.

support as has been recommended in recent reviews (see sections 2 and 4).

**Figure 5-3 Average annual funding growth, Australian Government R&D programs**




Source: Department of Industry, Innovation and Science (2019) and Tulipwood Economics analysis.

## 5.3 CRC-P funding and 'crowding out'

Since their introduction in 2016, CRC-Ps have proven extremely popular with industry due to the relatively simplified design, short timelines of funding rounds, simple application and contracting arrangements. Ninety-two applications were received in the first round, with eleven being funded or partially funded, attracting $51.8 million of collaborator investment on top of the government's $22.6 million. The latest completed round, round seven, yielded 110 applications, 16 of which were successful with government funding of $30.5 million. Round eight of the CRC-P funding is currently underway with the outcomes anticipated in December 2019. To date, 584 applications have been submitted, with 111 being successful and the investment on the part of the government being $233.2 million (see Annexure B for a list of all funding rounds and successes).

Table 5-1 (below) shows the increase in CRC-Project funding relative to the overall CRC Program budget for the years where funding has been fully allocated (i.e. up to round seven). Beginning in 2016-17, CRC-P consumed 10.7 per cent of total CRC Program funding. This proportion increased to 23 per cent in 2017-18. In 2018-19 and 2019-20, the proportion stands at 33.4 per cent (or one-third). We expect that when funding for rounds eight and nine have been fully allocated, 2020-21 and 2021-22 will likely exhibit a similar CRC-P to CRC Program proportion.

**Table 5-1 Proportion of CRC Program funding allocated to CRC-P, 2015-16 to 2022-23**

| Year | Total CRC Program* ($m, nominal) | CRC-Projects ($m, nominal) | CRC-Projects / CRC Program |
|---|---|---|---|
| **2016-17** | 149.5 | 16.0 | 10.7% |
| **2017-18** | 160.8 | 37.0 | 23.0% |
| **2018-19** | 167.3 | 55.8 | 33.4% |
| **2019-20** | 184.3 | 61.6 | 33.4% |

Source: Department of Industry, Innovation and Science (2019) and Tulipwood Economics analysis. Note: These figures may not be completely accurate because it depends on how individual Project proponents expend funding over the project lifetime. We have assumed an equal expenditure across the main years that a Project is in operation.
*This column shows the total funding for the CRC Program, which includes CRCs and CRC-Ps.

Notwithstanding the issue of crowding out, the continued low "*funding success rate*" (the percentage of applications funded) of CRC-Ps is a cause of serious concern. The funding success rate of 12 per cent is below the 17 per cent and 18 per cent funding success rates (already very low by global standards) of the National Health and Medical Research Council and the Australian Research Council, respectively, in 2016. More importantly, companies applying for CRC-Ps have well under half the funding success rates of the ARC Industry Linkage Program, which had funding success rates of 35.5 per cent in 2015, and 31.1 per cent in 2016.

Given that the government wishes to encourage more Australian companies to collaborate with public research organisations – and that the lack of such collaboration and coordination has been identified as a real hurdle to the take-up of new technologies and processes, it is important that the CRC-Ps remain competitive with other programs and that the low success rates do not deter prospective participants from applying. CRC-Ps are company/industry-led and research organisations cannot be the lead applicant. However, research organisations invest in CRC-Ps and if the funding gap continues to expand between the CRC-Ps and others, they will naturally favour programs that have a higher funding success rate. In other words, industry (which is favouring CRC-Ps) could be denied access to some of Australia's top research talent. When funding success drops too low, companies become reluctant to participate.

# 6. Findings and recommendations

This 2020-21 pre-budget submission has summarised the evidence from a number of recent reviews into the CRC Program and developed new analysis to support the submission.

In summary, there are three main findings in this submission:

**Finding 1**: Taken over the long-term, funding levels for the CRC Program are below its long-term average and have declined in both nominal and real terms compared to peak levels.

**Finding 2**: Since the mid-2000s, CRC Program funding has steadily declined as a percentage of GDP. Further, compared to 2009-10, CRC Program funding has declined as a percentage of total Australian Government investment in R&D, from 2.2% to 2.9%.

**Finding 3**: The introduction of the CRC-P stream, while a positive development in itself, is causing significant funding problems overall. This is because the CRC-P stream is drawing funding away from the main CRC Program.

## 6.1 Supporting Australian industry

In conclusion, the performance of the CRC Program and the government's reliance on it as a major source of collaboration between industry and academia warrant continued support and commitment. As described in this submission, successive reviews and studies have demonstrated the impact of the CRC Program, most notably its positive influence upon Australia's GDP, as well as its success in bringing partners together in collaboration to achieve a common goal. By supporting end-user focussed, collaborative research within the CRC Program, the government would be supporting industry and helping to achieve highly significant and lucrative outcomes across all segments of society and numerous sectors of industry.

The Australian Government can invest in the CRC Program with great confidence that it delivers for the Australian community. Almost 30 years of successful industry-led collaboration is testament to this. The CRC program has yielded highly significant and industry-changing results over this period and will continue to do so with the support of the Australian Government.

## 6.2 Recommendations

### 6.2.1 Recommendation 1

Given the success and positive reviews of the program, the CRC Association submits that the government commit to increasing its investment in the CRC Program by $50 million per year over the course of the forward estimates. This would involve an investment of an additional $200 million over four years from 2020-21, as shown in Table 6-1. This commitment would bring the overall level of CRC Program funding from its current level of $184 million (2019-20) to our recommended level of $250 million per year (by 2023-24).

### 6.2.2 Recommendation 2

Of this increase, we propose that 50 per cent be earmarked for government priority programs, such as addressing plastic waste, building a circular economy and investing in the space industry. These increases would help to renew and encourage interest in significant industry-research

collaborations. The Cabinet and Minister would retain the right to direct research to priorities within an established, high-performing program.

**Table 6-1 The cost to the government of recommended CRC Program funding**

| CRC Program funding | 2019-2020 ($M) | 2020-2021 ($M) | 2021-2022 ($M) | 2022-2023 ($M) | 2023-2024 ($M) |
|---|---|---|---|---|---|
| Current CRC Program commitment (to 2022-23), and proposed (2023-24) | 184.150 | 187.356 | 192.239 | 191.223 | 200.000 |
| Additional funding (proposed) | - | 50.000 | 50.000 | 50.000 | 50.000 |
| Proposed total CRC Program commitment | - | 237.356 | 242.239 | 241.239 | 250.000 |

Source: 2019-2020 Commonwealth Budget Papers and CRC Association Analysis.

### 6.2.3 Recommendation 3

The funding of government priorities for CRC-Ps could be targeted more effectively with greater (for example, three months) notice. The risk of funding projects at relatively short notice is that it can disrupt the funding rounds and valuable collaboration between business and the research community can no longer be assured. Furthermore, projects of lower quality may be funded at the expense of higher quality projects as vetting processes are cut short.

### 6.2.4 The economic benefits to exceed budgetary costs

The return on the proposed additional investment in the CRC Program would be in the form of real deliverables and numerous research achievements which to date have included:

- Capital Markets CRC's Australian surveillance technology, SMARTS, was acquired by NASDAQ in 2010 and is the foundation for identifying manipulation and insider trading in markets around the world.
- the launch of the revolutionary coiled drill rig by Deep Exploration Technology CRC, which drills at one-sixth the cost of conventional drilling;
- new ways of diagnosing Autism and a social skills training program by Autism CRC;
- the development of a system of predicting sheep health called *ASKBILL* by the Sheep CRC;
- the Cancer Therapeutics CRC's licensing deal with Pfizer for two advanced programs which delivered a $20 million signature payment along with the potential for a further $650 million in milestone payments. In addition to the licensing deal, a two-year multi-million dollar research collaboration with Pfizer is being managed by the Cancer Therapeutics CRC.[22]

[22] Annexure A provides a more complete sampling of the significant societal and economic benefits of the CRC Program.

# References


Allen Consulting Group, 2012, *The Economic, Social and Environmental Impacts of the Cooperative Research Centres Program*, Allen Consulting Group Pty Ltd

Arrow, K., 1962, *The Economic Implications of Learning by Doing*, The Review of Economic Studies 29

Australian Parliament, 2015, *The Senate Economics References Committee Report on Australia's Innovation System*, Canberra

Australian Research Council, 2016, http://www.arc.gov.au/selection-report-linkage-projects-2016

Department of Industry, Innovation and Science, 2018, *Cooperative Research Centres Program Over Time,* Canberra

Department of Industry, Innovation and Science, 2019, *Portfolio Budget Statements 2019-20 Budget Related Paper No. 1.11 Industry, Innovation and Science Portfolio,* Canberra

Elnasri, A., Fox, K.J., 2014, *The Contribution of Research and Innovation to Productivity and Economic Growth*, UNSW Australian School of Business Research Paper No. 2014-08

Ferris, B., Finkel, A., Fraser, J., 2016, *Review of the R&D Tax Incentive,* Commonwealth of Australia

Guellec, D., De La Potterie, B.V.P., 2002. *R&D and Productivity Growth*, OECD Economic Studies

Industry Commission, 1995, *Research and Development Inquiry Report*, Commonwealth of Australia

Innovation and Science Australia, 2016, *Performance Review of the Australian Innovation, Science and Research System*, Commonwealth of Australia

Innovation and Science Australia, 2017, *Australia 2030 Prosperity Through Innovation a plan for Australia to Thrive in the Global Innovation Race,* Commonwealth of Australia

Insight Economics, 2006, *Economic Impact Study of the CRC Program*, Insight Economics Pty Ltd

Miles, D., 2015, *Growth Through Innovation and Collaboration: A Review of the Cooperative Research Centres Program*, Commonwealth of Australia

OECD 2017, *Boosting R&D Outcomes in Australia*, Economics Department Working Papers No.1391, Paris

O'Kane, M., 2008, Collaborating to a Purpose, Review of the Cooperative Research Centres Program, Commonwealth of Australia

Productivity Commission, 2019, *PC Productivity Bulletin,* May, Canberra

Productivity Commission, 2019, *Trade and Assistance Review 2017-18*, Annual Report Series, Canberra

Romer, P., 1990, *Endogenous Technological Change*, Journal of Political Economy 98

Scott-Kemmis, D., 2018, *Myths, Crises and Complacency: Innovation Policy in the United States and*

*Australia*, United States Studies Centre, Sydney

## Online resources

https://www.theaustralian.com.au/higher-education/rd-spending-drops-below-oecd-average/news-story/86f921d3a51522e7efc19f5105732b53, accessed on 29 November 2019

https://www.smh.com.au/politics/federal/not-a-good-sign-australia-s-r-and-d-investment-slips-against-developed-peers-20190826-p52kvd.html: accessed 19 November 2019

https://consult.industry.gov.au/crc-programme-review/crc-programme-review: accessed 25 November 2019

https://www.afr.com/politics/bill-ferris-laments-weak-business-rd-feds-innovation-cold-shoulder-20181104-h17h70; accessed 29 November 2019

https://www.afr.com/politics/federal/budget-a-stunning-lost-opportunity-says-bill-ferris-20190403-p51aci; accessed 29 November 2019

https://en.wikipedia.org/wiki/Cooperative_Research_Centre#cite_note-9; accessed 29 November 2019

https://www.afr.com/technology/swap-failing-r-and-d-incentive-for-proven-grants-20190725-p52aup; accessed 29 November 2019

https://www.industry.gov.au/data-and-publications/science-research-and-innovation-sri-budget-tables; accessed 18 November 2019

https://www.pc.gov.au/research/completed/ict-use/ictuse.pdf; accessed on 12 November 2019

## Annexure A Sample of 2019 CRC achievements

The following list is a sample of CRC achievements. It is not a comprehensive list of all achievements from all CRCs.

The revolutionary coiled tubing drill rig, RoXplorer®, launched. RoXplorer® can drill at one-sixth the cost of conventional drilling and addresses the challenge of falling discovery rates for mineral deposits in Australia as well as addressing safety and environmental issues.

Two of Cancer Therapeutics CRC's chromatin-modifying programs were licensed by commercial participant, CTxONE, and subsequently licensed to Pfizer, in a deal worth over $20 million upfront, with the potential to deliver a further $650 million in milestone payments. Alongside this deal, sits a two-year, multi-million dollar collaboration agreement that will leverage the world-leading fundamental biology of research participants WEHI and the Peter MacCallum Cancer Centre.

In early 2019, an immuno-oncology project was promoted to Candidate Generation and drug development commercial participants, CTxONE and Synthesis Research, agreed to option the program. This commits the commercial participants to co-fund Candidate Generation, leading to increased funding for the project and allowing the CRC to drive it forward more rapidly with the aim of delivering a drug development candidate prior to the end of the CRC.

Capital Markets CRC's Australian surveillance technology, SMARTS, was acquired by NASDAQ in 2010 and is the foundation for identifying manipulation and insider trading in markets around the world.

Using monies from the sale of the technology SMARTS, Capital Markets CRC established the first CRC investment fund (Capital Markets Technologies) and have used the first $15m in funding to invest in three start-up companies bringing transparency (and ultimately fairness and efficiency) to the mortgage markets (www.dealmax.com.au), café and restaurant markets (www.ordermentum.com) and the building management marketplace (www.cimenviron.com).

The CRC set up www.digi.cash which has introduced a new digital currency to the world marketplace. Beyond digitising cash, the technology can digitise any asset and enable a financial marketplace (with instantaneous settlement) to be facilitated using a mobile device.

Through spin-off company Loricahealth (www.loricahealth.com) Capital Market CRC introduced Negotiator (a new software tool) to the Australian marketplace. The software streamlines negotiations between public health payers and hospital provider groups with an acknowledged

return on investment (by its first public sector user) of 50:1 based on an initial investment of $2m.

The CEO of Capital Market CRC won the 2016 PM Prize for Innovation for his work on bringing integrity to financial markets through the SMARTS software (www.smartsgroup.com) and transferring the ideas to the health marketplace (www.loricahealth.com).

CRC for
Water Sensitive Cities

The launch of Aquarevo in Lyndhurst - a brand-new water sensitive community - marks a new era in the commercialisation of innovative residential solutions. The first of its kind in Australia, the Aquarevo development showcases a research-based, industry-leading water and energy sustainability design that signals a significant reduction in domestic water consumption achieved through urban design. The CRC for Water Sensitive Cities, South East Water, and Villawood properties have worked together to envision and realise this project, whose homes offer the perfect combination of liveability and sustainability. Packed with water-saving features, each home requires approximately 70% less mains water than a regular suburban house.

AutismCRC

Autism CRC developed Australia's first National Guideline for Assessment and Diagnosis of Autism (approved by the National Health and Medical Research Council and launched by Ministers Hunt and Fletcher in 2018) defining an optimal care pathway for autistic individuals and others with neurodevelopmental conditions.

More than 12,500 individuals have registered to access the Guideline to date, including more than 6,500 professionals from the health, education and social service sectors, along with more than 3,000 parents and carers.

More than 42,000 infants and toddlers have been monitored using the Social, Attention and Communication Surveillance-Revised (SACS-R) tool. Over 1,000 community-based maternal and child health nurses have trained in its use.

Autism pathway was established on HealthPathways platform for GPs to access current evidence-based information to aid clinical decision-making around the health and wellbeing of individuals on the autism spectrum. Currently implemented for the Northern Queensland Primary Health Network, Autism CRC is now investigating the broader dissemination of these pathways to GPs and health professionals across Australia.

CRCHBP
FOR HONEY BEE PRODUCTS

Honey bee flora database for the south-west of Western Australia has been constructed and includes scientific identification of the melliferous flora, flowering, climatic and burn scar data.

‘Pollination Harmony’ project was completed and the report finalised for Medibee Apiaries Pty Ltd.

A trademark system to measure and report on antioxidant activity in honey was finalised through the Australian UAF Organisation.

A standard operating procedure for the FRAP antioxidant was developed for the blind testing to ensure standardisation of testing.

There are currently 16 PhD students, three new Masters and one Honours student.

Cell Therapy Manufacturing
Cooperative Research Centre

Two spin-out companies, Carina Biotech Pty Ltd and TekCyte Pty Ltd were established.

Carina is a high growth company focused on the commercialisation of CTM CRC’s CAR-T technologies for the treatment of cancer. In particular, its pan-cancer CAR-T potentially enables the targeting of a wide range of different cancers using a single CAR-T product (http://carinabiotech.com/our-technology/).

TekCyte is positioned to take CTM CRC’s technologies that improve cell bioprocessing to market, in particular, advanced surface coatings for cell culture. TekCyte is collaborating with global companies to improve the manufacture of therapeutic cells, enhancing cost-effective expansion to deliver significant cost of goods savings to cell therapy companies.

The CRC pioneered an industry-specific, tailored entrepreneurial PhD program for students.

CRC ALERTNESS SAFETY AND PRODUCTIVITY

In a first for the Australian heavy vehicle industry, a new partnership between the Alertness CRC and participant the National Transport Commission (NTC) will, through a combination of rigorous field and laboratory-based research, evaluate the impacts of the Heavy Vehicle National Law (HVNL) on heavy vehicle driver fatigue. Making use of increasingly-accurate alertness detection methods and sleep monitoring devices, the research undertaken by the Alertness CRC will support any future reforms of the HVNL fatigue laws – ultimately helping to keep heavy vehicle drivers and those around them safer on our roads.

In partnership with Philips, they have developed a wearable technology that can improve the quality of sleep, increase daytime energy, and reduce daytime sleepiness in people who sleep for less than 7 hours per night.

In partnership with Solemma and Monash University, they launched new circadian lighting design software in Australia that will help to improve alertness and sleep.

The Space Environmental Management CRC set a telecommunications world record when the Japanese Space Agency's satellite Hayabusa 2 received a laser signal from the CRC's Canberra headquarters some 6,700,000 kilometres from earth. The experiment validated the CRC's aim of being able to more accurately track and hopefully eventually maneuver space debris. They have proven that lasers can have the power and reach required to be useful manipulation of space debris in near-earth orbit.

CRC CARE's National Remediation Framework (NRF) was recognised and supported by the Heads of EPA in October 2019. The NRF, which harmonises best practice approaches to contaminated site clean-up across all Australian states and territories, is forecast to deliver a minimum five per cent reduction in total costs, amounting to more than $200 million through to 2026.

CRC CARE's work has saved its industry participants millions of dollars annually. A 2019 economic impact review estimated that spread across the entire sector this amounts to more than $5.4 billion of economic benefit to Australia – a return of almost $9 on every dollar invested by government and industry.

CRC CARE's best-practice strategies and guidance for managing PFAS-contaminated sites have improved the national effort to assess and remediate these high-priority emergent contaminants. The CRC's work, which complements and informs the PFAS National Environmental Management Plan, has delivered significant direct economic benefits for industry. According to the CRC's recent economic impact review, this includes more than $200 million through reduced need for remediation of PFAS that – based on the CRC CARE's risk-based approach – does not pose an environmental or health threat. In addition, sectors relying upon PFAS clean-up are now able to commence or accelerate project operations on this land, reducing their costs of development and spurring new economic activity.

CRC CARE's work on innovative acid sulfate soil remediation at East Trinity, Queensland, turned badly acidified land into a place where mangroves, native birds and other wildlife again flourish.

CRC NA has facilitated the formation of the North Queensland Agricultural Supply Chain Alliance which includes representatives from Townsville Enterprise, Advance Cairns, Greater Whitsunday Alliance, Qld Department of Agriculture and Fisheries, and Central Queensland University.

The CRC has an agreement with Food Innovation Australia (FIAL) to continue working towards a formalised memorandum of understanding which outlines opportunities to collaborate, and share

knowledge and resources to achieve common goals and identify areas for further investment.

IMCRC helps to skill the next generation of manufacturing talent through PhD scholarships, honours scholarships and industry internships. To date, IMCRC has supported 19 PhD and two Master students. IMCRC has also entered into a funding partnership with the Australian Mathematical Sciences Institute's (AMSI) APR.

As part of IMCRC's Industrial Transformation Program and with the aim of helping to catalyse the transformation of Australian manufacturing, IMCRC has successfully launched futuremap®, a business diagnostic tool that helps Australian manufacturing SMEs assess their maturity and capabilities across 13 areas of industrial and manufacturing competitiveness.

IMCRC signed an Engagement Agreement with Germany's Fraunhofer Gesellschaft which provides a framework for collaboration on joint projects and recognises IMCRC as Fraunhofer's preferred portal for Industry 4.0 in Australia and New Zealand.

CRC ORE conducted a successful full-scale production trial of Grade Engineering® at Sumitomo's Minera San Cristóbal operation in Bolivia. Grade Engineering is an innovative approach to the early separation of ore from waste material, minimising the impact of declining grades and productivity. The Bolivian trial resulted in an outstanding suite of outcomes which have demonstrated substantial economic impact for this lead zinc silver operation. The Grade Engineering work has been financially modelled by Sumitomo as being worth some US$450million in profit and US$257million NPV through extending the life of mine for an additional two years. A suite of multi-million dollar follow-up project work is now being considered by Sumitomo with a view to expand the technology application and provide a more sustainable life of mine going forward.

The Integration Extraction Simulator is providing productivity breakthroughs and new thinking in mining and metallurgical modelling, by creating a truly integrated virtual mining value chain. The simulator is a CRC ORE developed cloud-based simulation and optimisation platform designed to predict and optimise blasting and mineral processing performance. Mining majors BHP and Anglo American have adopted and embedded the technology at selected Chilean operations.

Prototype development and testing for two completely new sensor technologies funded by CRC ORE will be achieved at both the University of Adelaide and the National Research Council (NRC) in Canada. The University of Adelaide is developing a completely new fluorine sensor for the industry, which will be trialled at Newcrest and Glencore operations in Australia. NRC has developed a completely new Laser-Induced Breakdown Spectrometry (LIBS) based real-time mineral analyser which will be trialled before the end of CRC ORE's term at a BHP operation.

The flagship project being delivered through the Kal Hub is a $1.3m Integrated Screening and Particle Sorting initiative comprising five mining companies, three METS companies, Curtin University and Minerals Research Institute of Western Australia (MRIWA).

During the reporting period, CRC ORE supported 14 PhD students and five Masters students throughout Australia.

The total number of approved Soil CRC projects now stands at 36 after 24 new projects were approved by the Soil CRC Board at its August 2018 and January 2019 meetings. The majority of these projects commenced in 2018-19, with the remaining few commencing in the early part of 2019-20. The Soil CRC has now allocated over $14.5 million of cash resources to projects.

The Soil CRC Project Management System, 'SoilCentral' was launched. This system has revolutionised the project proposal submission process by enabling online submissions. It is being further enhanced to support ongoing project management by Soil CRC administration staff, Program Leaders and Project Leaders.

The CRCLCL exceeded its original goal of 10 megatonnes cumulative reduction in carbon emissions by 2020, enabling a projected economic benefit to Australia of $684 million by 2027. Over 120 projects have produced excellent results.

The Built to Perform report proves changes to the National Construction Code could improve energy efficiency in Australian Buildings by up to 56 per cent and cut household energy bills by $200-900 per year.

Low carbon schools education pilot program, which saved 266 tonnes of carbon emissions in Western Australia, is now a viable ongoing national program, ClimateClever.

Since commencing in 2014, the Centre is undertaking 33 industry projects and has 30 PhD scholarships.

The CRC Association award-winning Dwell Track passenger tracking technology with Downer and the University of Technology Sydney was patented, trademarked and trialled by the Sydney Trains rail network from August 2019.

Melbourne small-to-medium enterprise Airlinx has completed computational fluid dynamics modelling on air conditioning diffusers and airflow in train cabins to develop a model for improved thermal and air quality properties.

New battery materials, cell properties and energy management systems have been developed to progress the commercial viability of energy storage systems in the rail sector.

In total, 49 PhD students have been supported through industry projects, scholarships and internships.


The Australian National Disaster Resilience Index has been developed with governments and emergency service organisations across Australia and New Zealand. The Index provides a tool for policymakers to understand at a national level how resilience varies in different regions of Australia, providing a means to track change over time and to allocate resources that are relevant and targeted.

Improvements and validation have been made to a prototype, high-resolution, soil-moisture system called JASMIN, which is providing more accurate estimates of land dryness that underpin the fire danger rating and warning systems, fire behaviour and flood prediction models, and the development of heatwaves. This will flow on to improvements in emergency warnings issued to the public.

A new National Fire Danger Ratings System is drawing from a range of CRC projects in fire behaviour, fire ecology, weather and climate, predictive services, and communications and warnings. Based on this research, the new system will improve community awareness of risk exposure, provide greater scientific accuracy behind decisions, advice and warnings and give communities greater confidence in the information being provided.

Fuels3D is a program designed by researchers for fire and land managers in the field to quickly, accurately and consistently capture important information on fuel hazard and burn severity. This benefits organisations by reducing both staff hours in the field and individual biases in estimating bushfire risk.

The CRC Association awarded the CRC its highest award for the CRC sector, the 2019 Excellence in Innovation Award. This was awarded for the life-saving work by CRC researchers at the Queensland University of Technology and Macquarie University on changing how warnings for hazards and emergencies are worded, timed and targeted.

The Emergency Media and Public Affairs conference in June 2019 presented two awards to the CRC. The 2017 NSW bushfires community preparedness research by Dr Josh Whittaker at the University of Wollongong and Dr Mel Taylor at Macquarie University won the Excellence in Research award, while the conflicting cues research out of Queensland University of Technology by Dr Paula Dootson, Prof Dominique Greer, Sophie Miller and Prof Vivienne Tippett was highly commended. Dr Whittaker and Dr Haynes, both at the University of Wollongong, won the Judges Choice award, alongside Liam Mannix from *The Age*, for their article on lessons from the 2009 Black Saturday bushfires.

The FFW CRC won the academic category of an online global food waste challenge led out of the UK with entries across a range of categories from 15 countries.

The National Food Waste Baseline was launched on 20 March 2019 from the FFW CRC's Adelaide Headquarters by the Australian Government Minister for the Environment, the Hon Melissa Price MP.

The project portfolio operating software "MOMENTUM" was implemented.

Freight Data Study for the Department of Infrastructure, Transport, Cities and Regional Development led to the announcement and allocation of resources to the formation of a National Freight Data Hub.

Highly automated vehicles were deployed into research efforts in Queensland and New South Wales.

The second year of the undergraduate program is underway with 47 participating students.

Through its company HearWorks, HEARing CRC holds three patent families, comprising two Australian patents, three patents in the USA, two European Union patents, and one patent in Canada based on work commenced in the previous CRC for Cochlear Implant and Hearing Aid Innovation.

Through its Trustee company HEAR IP, HEARing CRC currently holds 11 patent families across a range of technologies, comprising five Australian patents, eight patents in the USA, and 11 patents in other countries including the European Union, China, Canada and Japan. An additional four patents were pending in different jurisdictions.

Through HEAR IP, HEARing CRC currently holds 22 trademarks.

Cochlear Ltd has acquired the OPAL patent family from HearWorks and will implement a clinical trial in China in the near future.

Cochlear Ltd has acquired the aTune pitch discrimination training program from HearWorks, and has implemented the technology in their Bring Back the Beat music rehabilitation suite.

Hearing Australia/NAL have acquired the HEARLab Technology and Bardy Tone patent families from

HearWorks. NAL is negotiating with a new commercial partner to ensure that HEARLab's software modules are made available to clinicians worldwide.

HearWorks, the commercial arm of The HEARing CRC has recorded over $600k in commercial income from licencing of HEARing CRC IP during the reporting period.

HEARing CRC has conducted 11 research contracts for commercial sponsors, returning over $105k in contract fees during the reporting period.

Through scholarship, in-kind and staff-funded programs and enrolments at Macquarie University, the University of Melbourne, the University of Queensland, and Western Sydney University, 26 PhD students have now completed their PhD programs in the HEARing CRC. An additional 10 PhD students are currently completing their PhD programs.

Audiology Australia has signed a contract with HEARnet Learning providing $50k in funding for the development of two specialist training packages, one focused on Infant Diagnostics and a second on Cochlear Implant Candidacy and Clinical Management.

Under a groundbreaking agreement between Digital Health CRC and one of its US-based participants, HMS (a US healthcare technology company), de-identified Medicaid data from nine US states is now being made available through the CRC for non-commercial research and academic use only.

The CRC is involved in a project devising algorithms for a personalised digital community healthcare model (with Flinders University and goAct).

A medication adherence platform for reducing the cost of medication errors and non-adherence is being developed (with the Peter MacCallum Cancer Centre and Swinburne University of Technology).

Digital Health CRC is involved in developing a mechanism to deploy digital tools aimed at lifestyle modification in primary care (with the University of Notre Dame Australia, Mercy Hospitals Victoria, Werribee Hospital Foundation and Archetype Health).

## Annexure B CRC-P Applications Received and Funded

| Round | Submitted | Compliant | Successful | Funding |
|---|---|---|---|---|
| One | 92 | 80 | 11 | $22.6mil |
| Two | 62 | 57 | 17 | $34.5mil |
| Three | 38 | 35 | 13 | $28.8mil |
| DNA* | 39 | 37 | 7 | $13.9mil |
| Four | 74 | 72 | 15 | $33.1mil |
| Five | 71 | 70 | 13 | $29.3mil |
| Six | 98 | 96 | 19 | $40.4mil |
| Seven | 110 | 106 | 16 | $30.5mil |
| Eight | 130 | N/A | N/A | N/A |
| Total | 714 | 553 | 111 | $233.2mil |

* Developing Northern Australia

## Annexure C Reviews of the CRC Program

Howard Partners, 2003, *Evaluation of the Cooperative Research Centres Program*, Department of Education, Science and Training, Canberra

Mercer, D., Stocker, J., 1998, Review of Greater Commercial and Self Funding in The Cooperative Research Centres Program: Report of the Steering Committee, Department of Industry Science and Tourism, Canberra

Miles, D., 2015, Growth through Innovation and Collaboration A Review of the Cooperative Research Centres Program, Canberra

Myers, R., 1995, *Cooperative Research Centres Program Evaluation: Changing Research Culture*, Report of the CRC Program Evaluation Steering Committee, Department of Industry Science and Tourism, Canberra

O'Kane, M., 2008, Collaborating to a Purpose, Review of the Cooperative Research Centres Program, Commonwealth of Australia

## Annexure D Impact/Economic studies of the CRC Program

Allen Consulting Group, 2005, The Economic Impact of Cooperative Research Centres in Australia**,** Allen Consulting Group Pty Ltd

Allen Consulting Group, 2012, The Economic, Social and Environmental Impacts of the Cooperative Research Centres Program, Allen Consulting Group Pty Ltd

Insight Economics, 2006, *Economic Impact Study of the CRC Program*, Insight Economics Pty Ltd

## Annexure E Findings of reviews of the CRC Program

| Review/Study | Year | Title and Main findings |
|---|---|---|
| **Myers, R** | 1995 | *Cooperative Research Centres Program Evaluation: Changing Research Culture*. Report of the CRC Program Evaluation Steering Committee, Department of Industry Science and Tourism, Canberra.<br>- Concluded that the CRC Program was well-conceived and had a positive impact on research culture. |
| **Mercer, D and Stocker, J** | 1998 | *Review of Greater Commercial and Self Funding in The Cooperative Research Centres Program*: Report of the Steering Committee, Department of Industry Science and Tourism, Canberra.<br>- Found that the CRC Program addresses important weaknesses in the national innovation system particularly the disincentives to collaboration, the weak links between research organisations and users, the lack of critical mass due to dispersion of Australian research, the lack of mobility of personnel between government research, academia and industry, and the challenges of effective international links for a country isolated from the international centres of research and innovation.<br>- Found that the program complements the work of other research entities such as universities, CSIRO and other research organisations.<br>- Found that it encourages greater industry involvement in guiding R&D in the public sector.<br>- Stressed the vital role of Commonwealth funding in the formation and development of a CRC, describing it as the 'glue' that unites research organisations and users to collaborate in planning, managing and performing long-term research and in postgraduate education<br>- Made recommendations to improve the management of CRCs, especially in relation to governance and a graduated funding model linked to performance reviews. |
| **Howard Partners** | 2003 | *Evaluation of the Cooperative Research Centres Program*, Department of Education, Science and Training, Canberra.<br>- Described the emergence of three types of CRC: (1) those delivering National benefits, generally through repair and replenishment of Australia's natural capital; (2) those delivering collective industry benefits and (3) those delivering commercial benefits through new businesses.<br>- Found the Program to be effective, noting that "*CRCs have performed a vitally important role in transforming publicly funded discoveries and inventions into products and businesses that are 'investment ready'*". |

| | | |
|---|---|---|
| | | - The report suggested streamlining administration to promote an outcomes focus in application, management and reporting processes and to reduce burden.<br>- Suggested more focus when undertaking project planning and in governance on commercialisation, including spinout companies. |
| **Allen Consulting Group** | 2005 | *The Economic Impact of Cooperative Research Centres in Australia*, Allen Consulting Group Pty Ltd.<br>- Found that the overall performance of Australia's economy had been considerably enhanced when compared to the performance that would otherwise have occurred in the absence of the Commonwealth Government's investment in rounds 1-7 CRCs between 1992 and 2005. |
| **Insight Economics** | 2006 | *Economic Impact Study of the CRC Program*, Insight Economics Pty Ltd.<br>- Found that the CRC Program was delivering very clear net benefits for Australian economic welfare.<br>- For each dollar invested in the CRC Program, Australian gross domestic product was cumulatively $1.16 higher than it would otherwise have been. |
| **O'Kane, M** | 2008 | *Collaborating to a Purpose, Review of the Cooperative Research Centres Program*, Canberra.<br>- Described the CRC as an iconic and highly influential program, having been copied by several countries.<br>- Suggested modifications to better align objectives to clearly-articulated major challenges, to ensure that a wider range of industry and service end-users participate and to increase flexibility.<br>- Eight significant recommendations were made.<br>- Proposed changes such as increases in funding, the reinstitution of public good outcomes and encouraging CRC applications in Humanities and Social Sciences were well supported by stakeholders.<br>- Found opposition to other changes, such as reducing funding terms to four years and placing less value on in-kind contributions versus cash contributions.<br>- Of the recommendations made, five were fully implemented; and three were partially implemented. |
| **Allen Consulting Group** | 2012 | *The Economic, Social and Environmental Impacts of the Cooperative Research Centres Program*, Allen Consulting Group Pty Ltd.<br>- Established that the Program has proven to be highly important to Australian research and development. |

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|---|---|---|
| | | - By linking researchers with domestic and international end-users, the program delivered significant economic, environmental and social impacts.<br>- Almost $14.5 billion of direct economic impacts are estimated to have accrued from CRC produced technologies, products and processes.<br>- Found the program generated an estimated net benefit to the economy of $7.5 billion or around 0.03 percentage points of additional GDP growth.<br>- Showed a 3.1 return on the government's investment. |
| **Miles, D** | 2015 | *Growth through Innovation and Collaboration A Review of the Cooperative Research Centres Program*.<br>A total of 18 recommendations were made, all of which were implemented.<br>- Recommended the establishment of CRC-Ps.<br>- Recommended the continuation of the CRC Program but it stated that it should be refocused and targeted to achieve the Australian Government's priorities for applied science and research.<br>- The CRC Program should be an industry-led scheme that enables industry to identify and champion collaborative applied research projects.<br>- The Program objectives should be revised to put industry front and centre and they should be actively involved in the development of CRC and CRC-P proposals.<br>- The overall application, selection, reporting and administrative system should be simplified with a more industry-focused selection and review process and an overall reduction of red-tape.<br>- CRCs and CRC-Ps should work with Growth Centres to share knowledge, experience and resources and achieve common goals<br>- The CRC Program model should be used and funded by other Australian Government portfolios to achieve their policy objectives. |