

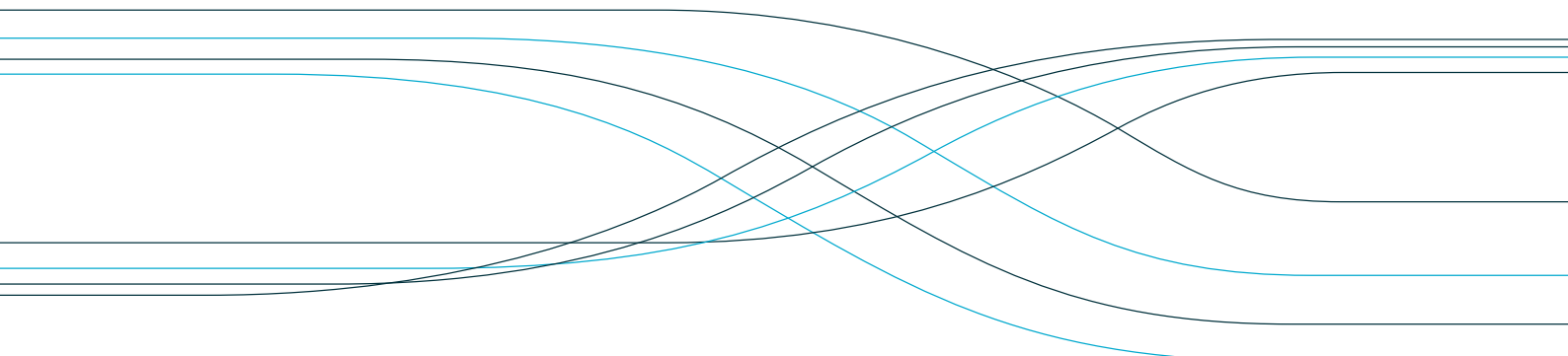


# CSIRO Submission 14/520

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*Boosting the commercial returns from research*

**December 2014**



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## Introduction

CSIRO welcomes the opportunity to provide a submission to the ‘Boosting the commercial returns from research paper’. CSIRO agrees with the importance of the four factors outlined in the discussion paper that are common to countries that successfully translate their research into commercial outcomes, namely research excellence, targeted research effort, cooperation between research and industry, and entrepreneurship.

In this submission, CSIRO seeks to comment on each of these factors taking the perspective of the requirements of the Australian innovation system as a whole. However in addition to this, for a number of these topics information on the relevant activities of CSIRO is also provided for contextual purposes. This submission is almost exclusively directed towards research investment and activities conducted in the public sector.

Within an Innovation System, research is often framed as to different types by whether it is ‘investigator-led’ or ‘mission-directed’:

- Investigator-led research is generally performed in universities, and is supported through government funded granting bodies such as the Australian Research Council. Investigator-led research is often directed towards the expansion of basic knowledge. At this discovery stage it is almost invariably highly speculative as to the utility of that knowledge when considered in the timeframes that apply in commerce.
- Mission-directed research is focused on addressing specific problems or opportunities. It is almost exclusively performed by publically funded research agencies which have a mandate to focus on research that delivers economic, environmental, and social benefits. Mission-directed research is – as the term implies – primarily designed and motivated to result in applied knowledge, including with commercial applications. Suitability for timely commercial application is often a stated requirement at the start of mission-directed research activities.

Although these two types of research activities have common requirements, including for example, the requirement of excellence of scientific method and leadership, inquiring intellects and a risk-taking approach, ethical approach, appropriate levels of resourcing and infrastructure, and regulatory compliance –the translation of research outputs into commercial outcomes will frequently involve different approaches in these two cases and this should be kept in mind when considering this submission.

All high performing national innovation systems balance investment between, and have different mechanisms for, managing mission-directed and investigator-led research. A ‘balance’ between mission-directed and investigator-led research improves the likelihood of pursuing and transitioning the best ideas into commercial outcomes. **A key strategic decision for investment in a public innovation system is the intended ‘balance’ between these, in order that required national outcomes are achieved. But a ‘system’ does not arise by chance, it must also be designed from a structural perspective to meet national needs.** The Case Study below on the German Innovation

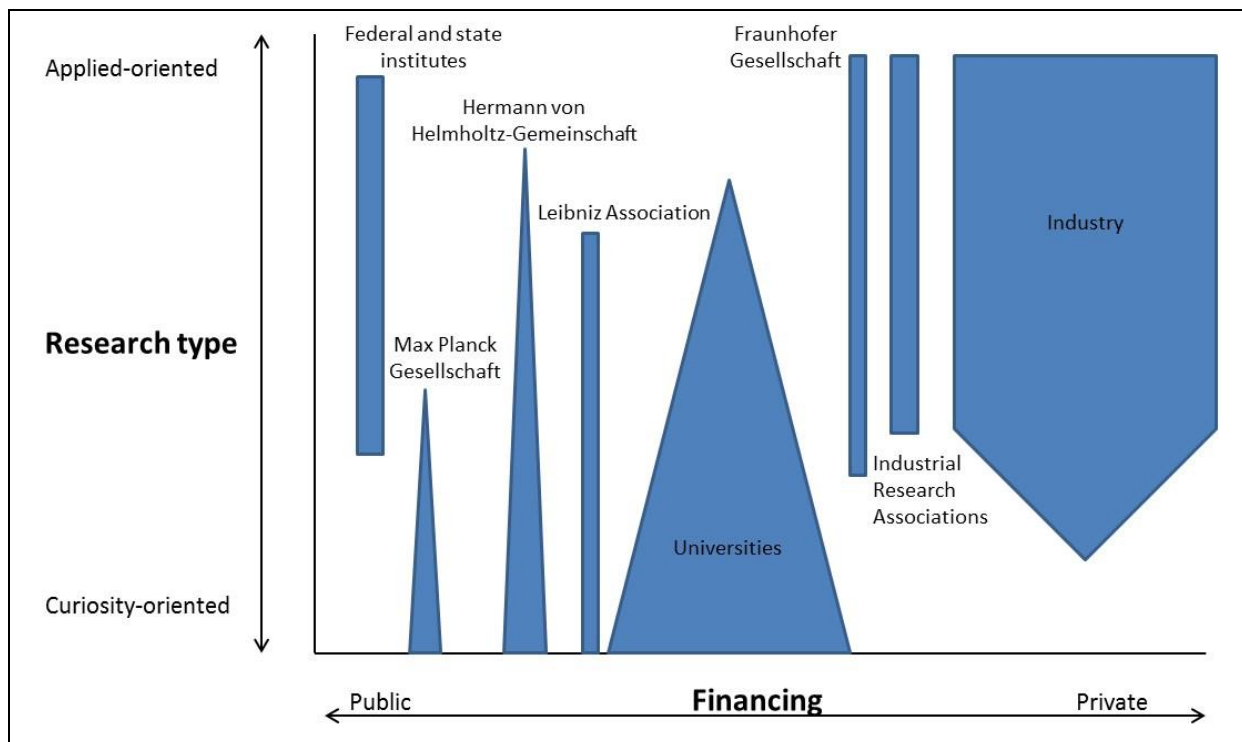
System provides an example of how a highly functioning innovation system, that produces high quality scientific outputs and enables industry to generate commercial returns, has been built.

#### **Case Study: The German Innovation System**

The German Innovation System provides an example of how a country can realise substantial benefits through targeted and balanced Government support of innovation. Government support in Germany takes many forms, including provision of strategic direction and research investment against those strategic directions. There are also other reasons why Government support for the German Innovation System is considered successful:

1. The German Government releases regular long term innovation strategies.
2. The roles of the organisations in the system are well defined, reducing resource inefficiencies and unnecessary capability and activity duplication. These roles are reinforced by different funding structures, for example the Fraunhofer institutes are funded at a 1:1 government:industry ratio whereas the Max Planck institutes rely almost entirely on state and federal government funds.
3. The balance of funding between the various sectors of the system is made based on national need (as set out in the long term innovation strategies), ensuring that resources are focused on resolving problems critical to Germany's sustainable global competitiveness. These needs are reviewed regularly to ensure the mix is appropriate.
4. Funding for research that delivers social, economic and environmental benefits is balanced against funding for supporting collaboration and funding that supports the development of new research capability and infrastructure.
5. The German Government recognises that its industry cannot compete on a volume cost basis but rather on the production of high value products and services. The importance of maintaining a high to medium-high technology economy, including an industry base that matches that and a long term industry focused R&D sector (e.g. conducted by Fraunhofer) illustrates the Government's commitment to maintaining this competitive advantage.
6. Research funding for industry is transparent with policy rules understood by both industry and the public sector.

The combination of well-defined funding streams and roles results in organisations that can focus on their strengths whilst ensuring that other requirements of the innovation system are covered by other organisations. This is best illustrated through the funding models of the major research organisations/ groupings in Germany as shown in **Figure 1**. This approach has enabled Germany to maintain a strong R&D sector despite increasing international competition.



**Figure 1: The German Innovation System: Source of financing versus research type.**

This diagram has been generated by CSIRO to illustrate the key players in the German Innovation System and further information about these players can be found for example at:

<http://www.germaninnovation.org/research-andinnovation/research-in-germany>

As well as ensuring a balance of research in the system, **it is important that the sectoral differences in the system are considered.** As CSIRO argues in its submission to the Inquiry into the Innovation System,<sup>1</sup> the ability of public sector research to support industry objectives varies greatly between sectors. An example of a well performing sector is that of pre-farm gate agriculture where the sector maintains a R&D system that can focus on opportunities based on their benefit to the industry by allowing farmers and other producers to have a say in the direction of research. CSIRO notes three key factors in this:

1. The Rural Development Corporations provide a mechanism that consolidates industry requirements for R&D into an integrated portfolio, with this research directed towards the needs of producers.
2. The research has relatively stable funding through a well-articulated mix of Government funding and industry levies.
3. Significant sector specific capability is maintained in organisations, including CSIRO, who have developed and maintained long term relationships with suppliers and key industry bodies.

The Manufacturing sector in comparison is more challenging as it combines low public and private investment in innovation (by international standards), is an industry sector that has a large

proportion of SMEs, with the attendant capital limitations, and has low numbers of industry based researchers.<sup>ii</sup> This is a major factor in Australia maintaining the lowest percentage value add (Approximately 6-7% of total manufacturing value add) in the OECD for high technology manufacturing<sup>iii,iv</sup> and places the sector at a significant disadvantage when competing globally.

CSIRO through its long history of engaging with industry believes its experience in working with industry is worth highlighting in the context of the discussion of boosting commercial returns. CSIRO delivers benefit to industry in a number of ways, including conducting research and services; providing near-to-market, technical support services in areas of CSIRO expertise; participating in collaborations with industry collaboration vehicles including 15 RDCs and 28 industry associations, and the 139 CRCs that CSIRO has participated in. In 2012-13, CSIRO conducted more than \$430m of research and development activities under these arrangements with firms, industry associations and collaborative arrangements. To support this engagement CSIRO runs a systematic client feedback program to understand how effective CSIRO is in delivering to its industry partners. This feedback along with advice from industry focused advisory groups provides part of the evidence base to help CSIRO improve its engagement with industry. **Attachment 1: CSIRO - Delivering Impact with Industry** outlines and provides examples of how CSIRO engages with the private sector to deliver commercial returns from research.

## CSIRO's response to the opportunities outlined in the paper

The Boosting Commercial Returns from Research paper includes a number of opportunities that CSIRO supports. CSIRO makes the following comments on each of the opportunities.

### 'Opportunity to assure Australia's research focus'

CSIRO supports the development of practical challenges and then aligning a planned proportion of the national research effort towards these with ongoing measurement of that alignment. To ensure that the practical challenges are useful in guiding research effort it is important that - as well as taking 'into account areas of current and future research excellence, industrial strength, global trends and community interests'<sup>v</sup> - they are limited in number and scope to enable both research organisations and industry to effectively focus their investments and activities. In summary, if Australia is to maximise the impact of its research generally, as well as the commercial outcomes from that research, then it must both play to its strengths and also align research to intended outcomes.

Aligning research programs to research challenges is a precondition for boosting the commercial returns from research, but is not in itself sufficient: **Tools appropriate to the type of research (investigator-led or mission-directed) and to the planning of the research activity from the perspective of how to achieve the intended commercial outcomes, should be implemented. In concert with this, appropriate tools and metrics should be introduced for monitoring and evaluating the economic, social and environmental impacts of publically-funded research.** To get the greatest return from investment in research where a commercial application is an intended outcome, consideration should be given to engaging partners from across the system - notably

industry - into the research activity and active portfolio management of research investments should be implemented.

### **Planning, monitoring and evaluating the returns from strategic/applied research**

For research focussed on translating research into commercial outcomes, tools to plan, monitor and evaluate the economic, social and environmental impacts of science are recommended. In the context of being a multidisciplinary applied research organisation, CSIRO has developed investment criteria based around the following: Appropriateness, Benefits to Australia, Path to Impact, Research Prospectivity, Research Competitiveness, Performance and Portfolio. CSIRO believes that these criteria are appropriate for its own role and may be beneficial –with modification - in guiding investment in publically funded commercially focussed research. Further details of CSIRO’s investment criteria are contained in **Attachment 2: CSIRO investment criteria**. The Productivity Commission has acknowledged the effort of CSIRO in developing a framework and supporting tools to plan, monitor and evaluate the economic, social and environmental impacts of our science.<sup>vi</sup> Through the framework, CSIRO has a portfolio view of the impact being pursued within and across Flagships to help make informed decisions. Planning future impact assists the alignment of research activity with Flagship goals and enables CSIRO staff to articulate and communicate the impact of their work. Articulating future impact, and monitoring progress towards that impact, provides greater confidence to our clients, the government and the general public.<sup>vii</sup>

These tools are also applicable, to varying degrees, to investigator-led research activities.

### **Engagement of research partners in strategic/applied research**

Early engagement with users of research output is ‘best practice’ for strategic/applied research. The delivery of the social, economic and environmental benefits of a research program is best enabled through the engagement of all partners – particularly end users - in the development, evolution and delivery of the R&D. This broad engagement helps shape the direction of the research to include the necessary steps for effective utilisation of the research outcomes into new products, services or processes. The reason this ongoing engagement is important is that strategic/applied research is not a linear process leading to a delivery event at the end of the research, but requires regular iteration to ensure that the research and its goals remain achievable and acceptable to key partners. An important demonstrator of the engagement of research partners is the investment of resources including financial commitment, but a particularly crucial factor for success is the attention of business management at the decision-making level.

A unified model of engagement with end-users of research output for investigator-led research is not so simple. The same logic, that engagement with end-users at an early stage can be applicable, however that activity requires a somewhat developed understanding of the utility of the new knowledge, which may be problematic in the case of investigator-led research.

## Active research portfolio management

CSIRO's research is actively managed within nine portfolios, known as Flagships.<sup>1</sup> The Flagships have goals developed around national challenges that are shaped and iterated with input from external experts from industry, government and scientific institutions that form its advisory committees and review panels. These active and participatory engagements provide incalculable value in terms of informing, challenging and refining CSIRO's research goals and pathways to maximise the likelihood of the uptake and adoption of Flagship research.

**It is CSIRO's experience that some form of active research portfolio performance management is essential to ensure that investment of public resources in research achieves its maximum environmental, economic or social impact.** Regardless of whether a CSIRO research activity is for the benefit of the public and/ or private sector, 'national benefit' in the context of national challenges and opportunities is the threshold criteria.<sup>viii</sup>

Active research portfolio management helps ensure the relevance of research by allowing for research to adapt to market, regulatory and other changes. It encourages the management of investment and resources through a mentality of 'fast fail' of projects, enabling active management through modifying or even cancelling projects that are unlikely to deliver on their intended impacts (see **Case Study: Performance Management in the Light Metals Flagship**).

Such active research portfolio management contrasts with the processes associated with the vast majority of investigator-led research grants<sup>2</sup>, where the management of the research activity is conducted within the processes of the grantee's institution. Where research is funded and conducted without active provisions to monitor progress or evaluate the outcomes and impacts, this lack of process and evidence makes it difficult to understand the effectiveness of individual grants and the programs as a whole. It also makes it difficult to inform future research investment decision making as well as communication with policy makers and industry funders on the benefits of research.

### **Case Study: Performance Management in the Light Metals Flagship**

An example of active portfolio management is that of CSIRO's former Light Metals Flagship. At the time of starting the Flagship, there was a national dialogue that suggested that an important national challenge was extracting more value from our resources industry through moving up the value-adding chain by local processing. Following evidence and external validation that there was mixed and low levels of interest from industrial partners in magnesium and aluminium research, despite the substantial technical and scientific progress that was being achieved by CSIRO researchers, the decision was taken by CSIRO to discontinue Flagship funding for magnesium and

<sup>1</sup> CSIRO manages its research through three lines of business; Flagships, Services, and National Facilities and Collections. These distinct lines of business enable CSIRO to use appropriate management structures to suit the needs of our clients and research partners.

<sup>2</sup> Including those funded through grant schemes funded by government



aluminium research. This funding was used to boost research in titanium, as there was strong interest from large multi-national corporations and local small and medium enterprises for CSIRO innovations in titanium processing to be brought to market faster. This has subsequently seen licensing of CSIRO research breakthroughs in titanium to Australian and global industrial partners who are now making substantial investments in establishing a domestic titanium production industry with links to global supply chains. Eventually the decision led to the Light Metals Flagship being closed with the remaining investment in titanium continuing through the Manufacturing Flagship.<sup>ix</sup>

### Research Specialisation

A longer term issue applicable to ensuring commercial outcomes from Australia's research capability, is in relation to the scientific discipline distribution of national research capability. Whereas the commentary made in the sections above applies to the commercial outcomes in both immediate and medium term future (e.g. a one – two decade perspective), the discipline specialisation issue is in relation to capability *per se* and whilst it requires consideration now, it has impacts for the two – five decade time period given the time required for capability development, especially the development of new capabilities.

Each country shows a level of specialisation as to the discipline profile of the science it conducts. Australian science has a specialisation in the fields of geosciences and environment/ecology, plant and animal sciences – this may reflect the long standing importance of the mining and resources and agricultural sectors of the Australian economy. Australian publications in these fields are more than 5% of global publications, whereas Australia produces 3.5% of global publications overall. Interestingly, the scientific output from Canada shows a similar specialisation towards these fields of science. Australian research in these fields also performs well; each of the three fields is at least 30% more cited than the global average and at least 9% more cited than the EU-15 average.

Conversely – Australia is proportionally underweight in the fields of chemistry, physics, mathematics, engineering and materials science. In these fields, Australian output is between 1.7 – 2.6% of global publications.

This specialisation data profile raises a question concerning the research requirements of the future Australian economy. Although it is not contemplated that the Australia will become a global *leader* in sectors that require intensive physical sciences – as currently are some Asian countries – nevertheless, these fields of sciences are fundamental to many sectors of the economy including the manufacturing and service industries. Development or expansion of capability in discipline fields requires multiple decades of investment. For these reasons, **a question worth contemplating is whether an intervention is required in the specialisation of the Australian R&D system, to address the current underweight of the physical sciences (chemistry, physics, mathematics, material sciences) in order to support delivery of commercial outcomes in the Australian economy of the 2020- 2050 period.**

For more detailed analysis of research specialisation, refer to **Attachment 3: National Discipline Specialisation – Design for Future State.**

## Key points

- *The development of practical challenges associated with research priorities will help drive the direction of research in Australia*
- *Commercially focussed research should be planned and monitored with the intended impacts in mind*
- *Engaging the right partners, early and during the conduct of the research, is key to obtaining a commercial return on research*
- *A portfolio management approach to the conduct of research undertaken in support of practical challenges should be contemplated*
- *The national research disciplines required for the long-term future economy is an important issue to be considered in the context of achieving commercial outcomes from research*

## ‘Opportunities to support collaboration’

Many of the challenges and opportunities facing Australia require leveraging capability from across the innovation system to deliver innovative solutions for the economy, society and the environment. For this reason, CSIRO recognises the importance of encouraging collaboration between the most suitable partners in getting the best return - whether social, environmental or economic - on research. It is a fundamental requirement of a high performing national innovation system that there is collaboration between the players in the system – particularly between industry and public research sector.

CSIRO is a strong supporter of the Research Connections programme and through our Small to Medium Enterprise Engagement Centre (See Case study below) helps researchers from both CSIRO and other research organisations engage with industry. **CSIRO believes that the Research Connections programme is an effective model for encouraging collaboration as it enables industry to increase their absorptive capacity, one of the fundamental weaknesses in the Australian innovation system.** CSIRO would like to highlight the effectiveness of the forerunner to the Research Connections programme, the Researchers in Business (RIB) program. Of the over 300 RIB projects, 44% involved SMEs with no previous engagement with Publically Funded Research Organisations (PFRO) prior to the RIB program, 78% of SMEs developed ongoing relationships with their PFRO following completion of a RIB and 54% developed relationships with other PFROs. CSIRO and the SME Engagement Centre team has facilitated 127 projects –through programs such as Researchers in Business where a researcher worked in a SME - that have a total value of \$13.86 million. SMEs contributed approximately 60% of the total project value with 33% being contributed by Government grants and 7% co-investment from CSIRO. Approximately 60% of the projects facilitated used a CSIRO researcher and of these, 70% were new clients. Collectively these clients continued to spend 400% more on research than the initial project facilitated by the SME Engagement Centre.

### Case Study: CSIRO’s SME Engagement Centre

Working with Australian SME’s is a key element in delivering on CSIRO’s role. Each year CSIRO works with over 1000 SMEs developing and delivering innovation to existing industries and through testing and evaluation.

The CSIRO SME Engagement Centre has been operating for five years and was established to build long-term connections between SMEs and research organisations across Australia's Innovation system. It is differentiated by (1) its market pull approach where it helps SMEs understand what may be possible and providing tailored solutions to the needs of SMEs rather than marketing research capabilities, and (2) its ability to connect SMEs to the most appropriate research capability, regardless of which research organisation it resides in. These two differentiating factors allow the Centre to consider the company and its need first, before thinking about the possible solutions. The Centre facilitates industry access to established program such as the Researcher in Business program. Examples of projects developed with the support of the SME Engagement Centre can be found here: <http://www.csiro.au/Portals/Partner/SME-Engagement.aspx>

The team was awarded the Australian Business Award for Innovation 2013 for its innovative approach to bridging the gap between SMEs and research organisations.

### Research Infrastructure

CSIRO acknowledges the important role that research infrastructure, particularly national-scale research infrastructure plays in supporting collaboration, including with industry. CSIRO hosts National Research Infrastructure on behalf of the scientific community to assist with the delivery of research in the nation's interest. These facilities and collections are not restricted to CSIRO personnel, they are world-class amenities, support significant global science programs that enable collaboration between researchers and industry and are of high relevance to industry and national economic prosperity. Further information on the role of CSIRO in research infrastructure is outlined in **Attachment 4: CSIRO's National Research Infrastructure role**.

CSIRO notes the importance of industry leadership in the use of National Research Facilities. Stakeholders from industry are already members of the Steering Committees of the Marine National Facility, and the Australia Telescope National Facility and thus are part of the process to determine strategic directions and time allocation to use these Facilities. CSIRO believes that industry led or co-led research using these Facilities could be further encouraged. This would require broadening the research user base and exploring investment pathways through a sound business model that leverages business investment while maintaining current access for Publically Funded Research Organisations to these facilities. A specific opportunity for greater research infrastructure collaboration is through NCRIS. Strengthening the focus of NCRIS to invest in outreach to researchers, industry and the community would enable greater use of research infrastructure. The Integrated Marine Observing System and Atlas of Living Australia are good models for the provision of outreach services.

Given the life span and required investment in research infrastructure, CSIRO recommends a long-term strategic approach. **CSIRO believes that the development of a roadmap for long-term research infrastructure investment would ensure a greater return on the investment in research including in relation to alignment with industry requirements**, and would welcome the opportunity to play an active role in providing advice.

Research infrastructure, as per other parts of the innovation system should utilise metrics for engagement, knowledge transfer, outcomes and impacts. The key performance indicators for National Research Infrastructure should include:

- Utilisation of the National Research Infrastructure and Collections by users, research days, observation time or operation time, access to and downloads of digital information, visitor days, the number of loans and/or online resources accessed
- National Research Infrastructure maintained and operated to appropriate standards
- Maintain or increase the proportion of collections available to researchers, and the public, including digitised and non-digitised collections
- Demonstrated response to national events by providing science-ready facilities in support of host and external party research

### Key points

- *The Government has an important role to play in connecting the innovation system to ensure capability from across the innovation system is effectively utilised*
- *The Research Connections programme has an important role to play in increasing the ability of Australian industry to develop research capability by developing long term commercially focussed relationships*
- *CSIRO believes that industry led or co-led research using research infrastructure could be further encouraged and that there could be a greater role for industry leadership in the use of research facilities*

### ‘Opportunities to reshape research grant incentives’

Grants have an important role to play in driving behaviours in the innovation system. However it is important that these incentives do not undermine strengths in the national innovation system such as scientific excellence:

- Mechanisms that focus on scientific excellence – such as investigator-led Discovery grants administered by the Australian Research Council – should focus on excellence through supporting the best research;
- Grants that are designed for delivering commercial returns or delivering impact should place high emphasis on bringing together the right partners to deliver on a commercial opportunity (whereas, solely adding commercial metrics to grant schemes that are fundamentally for investigator-led discovery activities, is unlikely in itself to result in the necessary industry involvement required to deliver strong commercial outcomes).

Funding mechanisms are often a major constraint for involving the right partners, as either through restricted eligibility requirements or excessive constraints on membership they limit the ability of organisations whether research or industry to be involved - For example, the length of CRC programs makes it difficult for Small to Medium Enterprises or new businesses to be involved. A number of countries are moving to more flexible mechanisms for funding research aimed at generating commercial outcomes as shown in the case study below.

#### **Case Study: Danish National Advanced Technology Foundation**

The Danish National Advanced Technology Foundation (DNATF) helps bring innovative products to market through a ‘mediated funding’ scheme which combines project grants with active facilitation and conflict

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management. At any given time, the organisation is supporting more than 300 different projects in key sectors of the Danish economy: construction, energy/environmental, biomedical, manufacturing, IT and communications, and agriculture. Each year, DNATF provides over \$US100 million in funding for these private-public partnerships. <sup>x</sup>

A principal goal of DNATF is moving technical breakthroughs out of the laboratory and into the market. As universities and businesses collaborate, they must work through a range of cultural differences. The experience, expertise, and approaches found in a research university are far different from those found in a commercial enterprise.

This process also delivers another enduring outcome, the development of human resources able to conduct mediation between research and industry. The success of DNATF's projects depends on effectively bridging this gap through a cadre of project mediation officers, who receive significant training through a joint DNATF/Harvard Business School Executive training program and form a peer group of STEM experts who have sought a career in supporting knowledge transfer into industry.

The selection of a firm to participate in the program 'helps it to stay financially viable and significantly decreases the likelihood of bankruptcy by up to 2.7 times (270%) four years after funding application. Selection also increases the average level of employment by 9.8 to 14.2 more employees for chosen firms, respectively two and three years after application. For innovative performance, selection of a firm for participation meant an increase in filed patents by up to 520%, granted patents by up to 430% and peer-reviewed publications 370%, but the effect of selection was mainly felt in quality of the innovations.'<sup>xi</sup>

It is also important when considering changes to grant incentives and metrics, that they adequately represent and measure the desired behaviour. For example research commercialisation income has been suggested as a possible measure to drive grants. However, these income streams are highly volatile (as illustrated by Australian commercialisation success stories such as Gardasil or Extended Wear Contact Lenses , as well as the experience of US universities) and in any case are quite delayed. In addition, as the majority of licensing occurs in the early stages when commercial value is difficult to determine, this generally leads to commercialisation revenue being subject to an uncertainty discount. The impact of a policy that encourages higher commercialisation revenues may confound negotiations between the parties, delay collaboration by researchers with industry, make it more expensive for industry to work with research organisations and result in less research innovation being commercialised.

### Key points

- *Funding for research aimed at delivering commercial research should be flexible as a wide number and range of organisations are often required to deliver commercial returns*
- *It is important that any changes to research grant incentives and metrics do not unduly impact the ability of researchers (notably in universities) to conduct investigator-led research*
- *It is important that incentives for grants and metrics for public research agencies encourage the desired behaviour. This is particularly challenging for grants focused on driving research-industry collaboration*

## **‘Opportunity to ensure graduate industry skills’**

Research training provides a significant opportunity to provide graduates with business, management and entrepreneurial skills. CSIRO acknowledges the work that the Office of the Chief Scientist is undertaking in supporting a more strategic approach to Science, Technology, Engineering and Mathematics through the ‘Science, Technology, Engineering and Mathematics: Australia’s Future’ paper.<sup>xii</sup>

Higher degree research training has a particularly important role to play in generating commercial returns from research. Hermann Hauser – a key driver behind the UK Catapult Program – argues that the return a government gets from the graduating students is at least 100 times what it gets from other commercial outputs of research.<sup>xiii</sup> CSIRO supports this important role through supervising and or sponsoring over 750 research students each year to undertake research that is focussed on delivering economic, social and/ or environmental benefits. In addition CSIRO is involved in programs run by universities that aim to improve the commercial skills of graduates such as the Australian Technology Network Industry Doctoral Training Centre.

### **Key point**

- *There is considerable benefit for the nation in supporting researcher training, however opportunities exist to provide graduates with better business, management and entrepreneurial skills*

## **‘Opportunities to encourage innovation by Australian businesses’**

A key driver of innovation is the flow of knowledge across the innovation system. For this reasons CSIRO supports programmes that focus collaboration and build scale in areas of key national interest. Industry Growth Centres and CSIRO’s Global Research Precincts are two examples of such programmes.

The recently announced Industry Growth Centres should take a critical role to play in focussing collaboration in the national innovation system. By providing information that enables the right collaborations to occur and funding selected projects with high returns, the Centres have the potential to support industry grow the commercial returns from research.

CSIRO’s Global Research Precinct strategy has the aim of bringing the very best of Australia together to increase Australia’s global competitiveness. Global Precincts will provide opportunities for promoting excellence to the world, fostering new inbound investments and attracting the world’s best and brightest science capabilities. These are the: Natural and Environmental Sciences Precinct in Canberra; Ecosciences Precinct in Brisbane; National Resource Sciences Precinct in Perth; Australian Manufacturing and Materials Precinct in Clayton, Melbourne; and the Human Life Sciences Precinct in Parkville, Melbourne. Through these precincts CSIRO is connecting organisations (universities, industry, governments, and the community), catalysing collaborations and encouraging a more coordinated approach to addressing research challenges and assisting the shared design, use and management of research infrastructure.

## Key Point

- *Through facilitating the flow of knowledge, programmes such as Industry Growth Centres are important in driving innovation.*

### ‘Opportunity to encourage entrepreneurial culture’

CSIRO applauds the initiatives that some universities have introduced into their curriculum to cover entrepreneurial thinking e.g. at UNSW and UTS. The increase in establishing Student-led incubation and shared workspace facilities on campus is also a good catalyst to encourage entrepreneurs e.g. the Incubate centre at Sydney University. In combination with the larger more professional incubation facilities provided by the likes of ATP Innovation and the associated training and networking opportunities, provides a good platform for entrepreneurs to thrive. CSIRO has recently taken some of its teams through the “Lean Launch Pad” program hosted by UQ and see this as a platform to help bring entrepreneurial thinking into CSIRO.

An approach that CSIRO utilises to encourage entrepreneurial ideas with its partners and amongst its staff is running “Challenge workshops”. A challenge workshop is a useful method for engaging with a potential partner or client in a workshop setting to develop a shared understanding of needs and capabilities across potential areas of collaboration. The format is best used following initial meetings or engagements which have established high level interest and capacity of the prospective client to work with CSIRO, and the potential for the partner to benefit from CSIRO capabilities. There are significant opportunities in the Australian Innovation System for bringing together teams from across Industry and the Research sectors to focus on areas of shared interest with the aim of harnessing the strengths and knowledge from both sectors.

### ‘Opportunity to reform IP arrangements to assist collaboration’

CSIRO believes that significant gains can be made in reforming IP arrangements in the innovation system, notably through the development of standard IP principles as has been an initiative in the UK where the “Lambert toolkit” has been developed<sup>3</sup>. In addition – and to facilitate the “knock-on” relationships between the research and industry collaborators - CSIRO argues that more flexible contracting arrangements should be considered for government research grants with the grantee organisation.

To ensure a reasonable and standard approach for engaging on intellectual property, CSIRO has developed a list of principles when enabling the use of its intellectual property. For further information on how CSIRO enables industry to utilise the intellectual property that it develops refer to **Attachment 5: CSIRO’s Policies and Posture of transfer of Intellectual Property to Industry**.

CSIRO contracts with a vast array of different Commonwealth departments, agencies and companies. Each of these Commonwealth entities administers different programs of funding ranging from the low-value, low-risk procurement of research services to large-scale infrastructure

<sup>3</sup> See <https://www.gov.uk/model-agreements-for-collaborative-research>



investments. Most of these Commonwealth entities have their own set of preferred contracting terms.

A recent analysis of negotiations with some of these Commonwealth entities revealed that the imposition upon CSIRO of different Commonwealth contractual terms places a significant administrative burden on CSIRO, which CSIRO is often obliged to pass onto its collaborators. Furthermore, there are many terms in these contracts which are not risk-adjusted to reflect the fact of one Commonwealth entity contracting with another.

CSIRO acknowledges that efforts have been made to overcome this difficulty, for example the development of the Commonwealth Low-Risk Grant Agreement Template issued by the Commonwealth Department of Finance (see <http://www.finance.gov.au/financial-framework/financial-management-policy-guidance/grants/grant-agreement-template-project.html>). However the benefits the Low-risk Grant Application Templates could provide are not being realised because many Commonwealth funding bodies seem reluctant to use the templates.

CSIRO supports the Recommendation on contracting developed in the 2012 Advisory Council on Intellectual Property (ACIP) review of *'Collaborations Between the Public and Private Sectors: The Role of Intellectual Property'*. With regard to contracting the Council recommended the following:

*'Recommendation 5: Request that the Coordination Committee on Innovation (CCI) promote and encourage the use of flexible terms and conditions in Australian Government grants and research contracts, including those specifically related to background and project IP licences, warranties, indemnities and moral rights.'*

*Considerations should include:*

- *collating and communicating information about existing initiatives and previous work undertaken in relation to such terms and conditions and the circumstances in which their flexible application is appropriate*
- *increasing awareness among Commonwealth and PFRO legal and procurement practitioners of the flexibility available in the terms and conditions of Australian Government grants and research contracts (including those specifically related to background and project IP licences, warranties, indemnities and moral rights)*
- *establishing a process for government agencies to report on the extent that such flexibility is being applied.'*

### **Key points**

- *Standard IP principles across publically funded research organisations would make it easier for industry to engage with researchers.*
- *Government should encourage the use of flexible terms and conditions in Australian Government grants and research contracts.*



## Principles to achieve strong industry/research linkages

Based on CSIRO's experience as the single largest participant in programmes aimed at fostering industry relevant R&D (such as the CRC and Rural R&D programmes) and through an analysis of domestic, international and our own programmes that are aimed at supporting industry led innovation, CSIRO believes that the following seven principles should be applied to industry focused research:

Principle	Explanation
<b>1. Strategic prioritisation by User Stakeholders</b>	<p>Let industry and other user stakeholders lead the selection of the highest potential opportunities to grow productivity and competitiveness.</p> <p>Prioritise only those opportunities where sufficient scale can be achieved to address the opportunity.</p>
<b>2. Merit based selection of research providers</b>	<p>Select based on merit those few collaborators who have the right world-class skills to deliver a specific opportunity.</p> <p>Prioritise collaborators with past success and experience.</p>
<b>3. Operational efficiency</b>	<p>Design a management structure of program that is efficient, manages the collaboration with an output focus and is time-limited, and supports the alignment of the activity to the partners.</p> <p>Develop a "collaboration in a box" toolkit that enables the streamlined and efficient operation of each new collaboration.</p>
<b>4. Time bound</b>	<p>Encourage the "creative destruction" of initiatives and collaborations when the job is done.</p> <p>Build in flexible and fast approaches that can be tailored for a specific opportunity so that projects can draw on capabilities from across the innovation system with appropriate partners being brought into and leaving the collaboration as required.</p>
<b>5. Monitor Impact to remain impact focussed</b>	<p>Consider the delivery of impact when designing research projects, including issues such as the absorptive capacity and business skills of partners.</p> <p>Conduct consistent and comparable pre- and post impact evaluations that will inform future investments.</p>
<b>6. Skills focused</b>	<p>Broaden skill development to develop "innovation entrepreneurs" who can turn inventions into opportunities.</p> <p>(Models that can be used are ones such as the existing "Researcher in Business" model and the recently announced SIEF "STEM+Business" investment to put post-doctoral level researchers into business)</p>

<b>7. Active Portfolio Management through direct project funding</b>	<p>Programme such as the Cooperative Research Centres should fund projects, not funding entities per se. (This moves closer to a “venture-type” approach to project selection and management of the programme’s investment portfolio).</p> <p>By funding projects directly, the programme can better manage the funding risk profile, ensure that funded projects can adapt to market, regulatory and other changes by modifying or cancelling projects unlikely to deliver their intended impacts, and ensure that there is appropriate funding coverage across the innovation value chain.</p> <p>It can also ensure that funded projects are clearly suited to the programme.</p>
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## **Attachment 1: CSIRO - Delivering Impact with Industry**

See Attachment 4 of CSIRO's submission to the Senate Economics reference Committee, at:

[http://www.aph.gov.au/Parliamentary\\_Business/Committees/Senate/Economics/Innovation\\_System](http://www.aph.gov.au/Parliamentary_Business/Committees/Senate/Economics/Innovation_System)

## Attachment 2: CSIRO investment criteria

Criteria	Considerations
<b>1. Investment Potential</b>	
<b>Appropriateness</b>	<ul style="list-style-type: none"> <li>The research is consistent with CSIRO's <b>mandate, role, strategy</b> and prevailing Government <b>policy</b></li> <li><b>CSIRO is the most appropriate organisation</b> to undertake the research, and no other organisations are better placed</li> </ul>
<b>Benefits to Australia</b>	<ul style="list-style-type: none"> <li>The <b>research outcomes sought will deliver a clearly articulated and compelling benefit</b> (impact) for Australia relevant to the economy, society and/or environment</li> <li>The measurable outcomes sought represents a strong return on investment relative to the likely whole of life costs of the research</li> </ul>
<b>Path to Impact</b>	<ul style="list-style-type: none"> <li>There is a clear and feasible path to impact for the research including <b>demonstrated client and end user interest</b></li> <li>We can demonstrate the ability to form <b>commercial relationships</b> with appropriate collaborators, stakeholders and clients to support the resourcing, development and adoption of the research</li> </ul>
<b>Research Prospectivity</b>	<ul style="list-style-type: none"> <li>Do we have good evidence that we have identified <b>the right science challenges</b> to deliver the impact sought?</li> <li>Are the science challenges <b>both ambitious and future oriented</b>?</li> <li>Given our resources, is the necessary technical progress likely to be <b>realistically achievable</b> within the timeframe?</li> </ul>
<b>Research competitiveness</b>	<ul style="list-style-type: none"> <li>Does the research area have, or is it likely to be able to develop, <b>science output performance that is world class</b> or has the realistic potential to become world class (at least top 1% in world)</li> </ul>
<b>2. Performance</b>	
<b>Performance</b>	<ul style="list-style-type: none"> <li>Considering all relevant factors given the nature of the impact and science challenge, has the research area demonstrated sufficient overall Impact, Science and Innovation capacity performance to warrant support for the</li> </ul>

	investment case?
<b>3. Management of Portfolio considerations</b>	
<b>Portfolio</b>	Pragmatic considerations must always be applied to criteria based evaluation. These include strategic considerations such as for a desirable shift in <b>portfolio balance, management response</b> i.e. the ability of management to undertake a ‘turnaround’; for <b>capability retention / option value</b> – understanding that capability is difficult to restart once exited, adverse impact on <b>external revenue</b> with spill-over effects; and/or <b>other constraints</b> – e.g. political, cultural, reputational, contractual, financial.

## Attachment 3: National Discipline Specialisation – Design for Future State

Each country shows a level of specialisation as to the discipline profile of the science it conducts. Analysis of the scientific publication output from Australia can also be used to provide a perspective on the scientific specialisation of Australia<sup>xiv</sup>. This analysis is conducted by comparing the proportion of Australia’s overall publications in each science field, relative to the proportion of publications in that field within total global publications. This can be supplemented by the average citation rate of the papers in the science field.

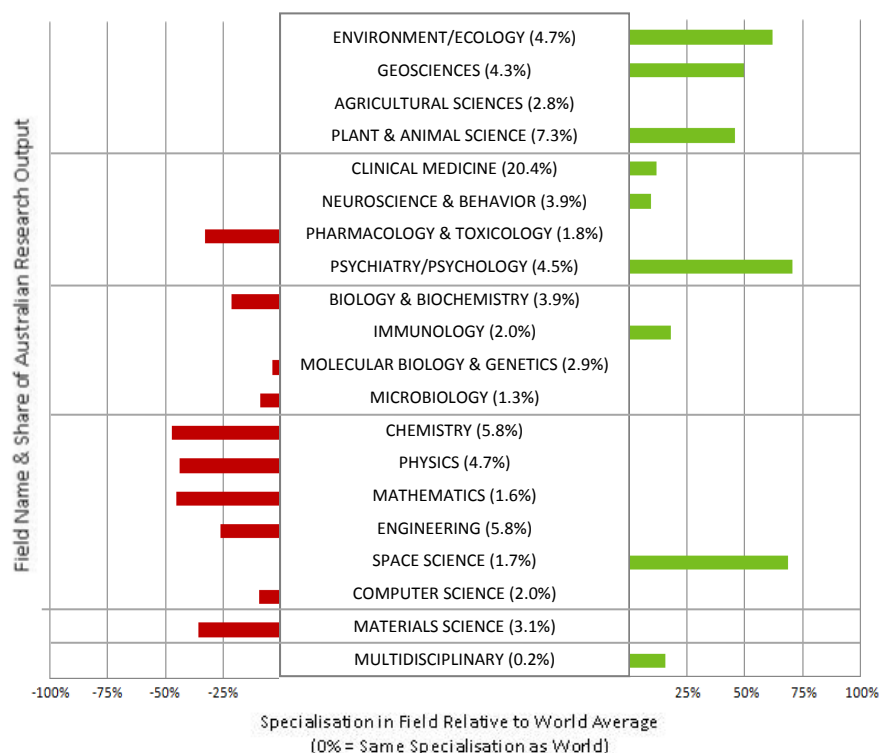


Figure 2: Australian Discipline specialisation relative to world average output.

The %s alongside the discipline name shows the proportion that those scientific publications are of total Australian publications. A red bar indicates that the output in that discipline is below global average of total publications; conversely a green bar indicates that Australia specialises in that discipline as compared to global average for that discipline. No bar indicates that for that discipline, Australian output is at the same proportion of national output as is that discipline in World average publication output.

**Error! Reference source not found.** shows that Australian science has a specialisation in the fields of geosciences and environment/ecology, plant and animal sciences – which may reflect the long standing importance of the mining and resources and agricultural sectors of the Australian economy. Australian publications in these fields are more than 5% of global publications - see Table 1 overleaf - whereas, Australia produces 3.5% of global publications overall. The scientific output from Canada shows a similar specialisation towards these fields of science. Australian research in these fields also performs well; each of the three fields is at least 30% more cited than the global average and at least 9% more cited than the EU-15 average.

Conversely – and this is potentially the more important issue – the Australian specialisation reflects a proportional underweight in the fields of chemistry, physics, mathematics, engineering and materials science. In these fields, Australian output is between 1.7 – 2.6% of global publications. Fortunately, although Australia does not specialise in these fields, the citation rates for Australian publications in these fields are between 20 – 35% above global averages and between 6 – 23% above the EU-15 averages.

This specialisation data profile raises a question concerning the scientific field requirements of the future Australian economy. Although it may not be contemplated that the Australia will become a global *leader* in sectors that require intensive physical sciences – as currently are some Asian countries which, accordingly, have scientific specialisation in these fields – nevertheless, these fields of sciences are fundamental to many sectors of the economy including the manufacturing and service industries. Development or expansion of capability in discipline fields requires multiple decades of investment. For these reasons, a question worth contemplating is whether an intervention is required in the specialisation of the Australian R&D system, to address the current underweight of the physical sciences (chemistry, physics, mathematics, material sciences) in order to support delivery of commercial outcomes in the Australian economy of the 2020- 2050 period.

**Table 1: World, Australian and CSIRO Discipline specialisation**

	<b>Research Field as % of WO Publications</b>	<b>Australian output as % of WO Publications in Field</b>	<b>CSIRO output as % of AU Publications in Field</b>
ENVIRONMENT/ECOLOGY	2.8%	3.5%	17.5%
GEOSCIENCES	5.0%	2.8%	18.5%
AGRICULTURAL SCIENCES	11.1%	1.8%	19.9%
PLANT & ANIMAL SCIENCE	18.3%	3.9%	13.6%
CLINICAL MEDICINE	2.3%	3.2%	0.6%
NEUROSCIENCE & BEHAVIOR	7.8%	2.6%	0.8%
PHARMACOLOGY & TOXICOLOGY	2.9%	5.7%	1.5%
PSYCHIATRY/PSYCHOLOGY	2.9%	5.2%	0.4%
BIOLOGY & BIOCHEMISTRY	1.7%	4.1%	4.7%
IMMUNOLOGY	4.9%	2.3%	2.1%
MOLECULAR BIOLOGY & GENETICS	2.9%	1.9%	5.1%
MICROBIOLOGY	1.4%	3.2%	9.0%

CHEMISTRY	3.0%	3.4%	8.9%
PHYSICS	0.2%	4.0%	5.4%
MATHEMATICS	3.5%	3.8%	2.0%
ENGINEERING	2.6%	2.4%	6.2%
SPACE SCIENCE	8.4%	2.0%	19.8%
COMPUTER SCIENCE	5.0%	5.1%	7.7%
MATERIALS SCIENCE	2.7%	6.0%	11.9%
MULTIDISCIPLINARY	1.0%	5.9%	8.3%
All Fields	100.0%	3.5%	6.1%



## Attachment 4: CSIRO's National Research Infrastructure role

CSIRO hosts National Research Infrastructure on behalf of the scientific community to assist with the delivery of research *in the nation's interest*. These facilities and collections are not restricted to CSIRO personnel, they are world-class amenities, support significant global science programs and are of high relevance to industry and national economic prosperity.

There are two types of National Research Infrastructure:

- **National Facilities:** CSIRO hosts National Facilities that provide world class research infrastructure relevant to all sectors of economic activity, and are used by the Australian research community and their research partners to investigate issues of national significance.
- **National Collections:** CSIRO hosts National Collections that are a knowledge powerhouse for research and development, providing resource and biological information potentially useful to aid research and development in many industries (e.g. agriculture, fisheries, aquaculture, pharmaceutical, food). The National Collections are used by the Australian research community and their research partners and are increasingly accessed by the public. The National Collections are storehouses of information on Australia's biodiversity and other aspects of the environment. They support a significant part of the country's taxonomic, genetic, bio-geographical and ecological research and are a vital resource for research and development of Australia's resources. The Collections cover the curation of each collection and the essential core research to make it "science usable". The Atlas of Living Australia is the mechanism to make the data available in electronic format to the wider community.

National Facilities are owned and/or operated by CSIRO. These facilities can be accessed by the Australian research community and international users for the purposes of science. Facilities are resourced with CSIRO staff to run and be "science ready" to support the facility's operations. These facilities include:

- Australian Animal Health Laboratory (AAHL)
- Australia Telescope National Facility (ATNF)
- Marine National Facility
- Pawsey Supercomputer Centre.

National collections are those amenities where CSIRO is the custodian of the national collections that are of Australian and international significance. These collections are available for use by the Australian research community and international community and increasingly are also publicly accessible. Each collection is supported with CSIRO staff to curate and maintain the collection. CSIRO will continue to steward collections in a manner which utilises the power of digital and genomics technologies to provide rapid access to comprehensive, reliable and validated data coupled with expert knowledge. These collections include:

- Australian National Fish Collection

- Australian National Insect Collection
- Australian National Herbarium
- Australian National Wildlife Collection
- National Tree Seed Collection
- National Algae Culture Collection
- Atlas of Living Australia.

CSIRO also plays a key role in developing global level infrastructure and is leading the building of the Square Kilometre Array in WA.

### **eResearch Services**

- CSIRO's eResearch services can lift productivity and competitiveness of industry through secure shared national computation and data infrastructure are able to
  - Facilitate access to world class eResearch capability including High Performance Computing, Cloud and Big Data Analytics
  - Provide access to leading expert advice, services and tools surrounding computation and data
  - Accelerate the development of collaboration and communities of practice through extensive partner networks
  - Accelerate multidisciplinary skills, training and career development for convergent research and ICT skills.

## Attachment 5: CSIRO's Policies and Posture of transfer of Intellectual Property to Industry

### Context

CSIRO's function is:

*'to carry out scientific research for ... assisting Australian industry; furthering the interests of the Australian community; contributing to the achievement of Australian national objectives ... to encourage or facilitate the application or utilization of ... research ... or any other scientific research ...'.*

In order to achieve these objectives, CSIRO manages its intellectual property in a strategic manner and makes accessible research results in an appropriate manner for the intended use. CSIRO has a bias towards public disclosure of new knowledge, for much of its research portfolio and publishes approximately 2700 scientific articles each year.

The pathways to distribution and transfer of knowledge and technology are various – conference papers and articles in the scientific literature; reports to government, in parliamentary forums and to industry; forums; people exchanges and collaborations; media communications; as well as through contractual means such as licensing, formation of spin-out companies, and the sale or exchange of rights. All of these paths can be valid mechanisms for generating impact, although on a case-by-case basis one or more of these will be more appropriate transfer mechanisms than others.

Intellectual property management – and where appropriate, registration of the intellectual property rights – are tools to achieve these desired outcomes. CSIRO protects its intellectual property where it considers that is appropriate to support subsequent commercial development of the rights by commercial collaborators or to facilitate follow-on capital investment by the market in technology development and its adoption. CSIRO also seeks protection for intellectual property that may be used as a platform to encourage collaboration or to obtain access to other people's important intellectual property. Such protection (which mechanisms are also a form of public disclosure, albeit delayed) preserves greater choice later on as the research knowledge is further developed, including the options for making that intellectual property available, freely or widely.

When developing intellectual property in collaboration with other parties (and much of CSIRO's research is collaborative with other parties), CSIRO works with those partners to identify the party that is best placed to manage intellectual property in the national interest.

### CSIRO's Policy

CSIRO has obligations to comply with government policies and international protocols, including respecting the intellectual property (IP) rights of others. The CSIRO Board has approved a set of IP Principles, aimed at being transparent with collaborators and clients and to facilitate early clarity of IP access rights. These Principles (see below) have been published on the [csiro.au](http://csiro.au) website.

## TEN PRINCIPLES FOR GENERATING IMPACT FROM INTELLECTUAL CAPITAL

1. Our primary purpose in generating and transferring knowledge is to achieve impact.
2. We will strive to choose the best transfer path to maximise impact. These pathways include public dissemination, exclusive or non-exclusive licensing, assignment or reciprocal agreements to increase collaboration and access to third party Intellectual Property Rights.
3. We seek to ensure that dealings and agreements with third parties appropriately preserve and protect IP, and provide a sound governance framework for IP decision making.
4. Ownership and control of IP should generally vest with the party best placed to manage the intellectual property across the full scope of the technology and its potential utilisation.
5. If we agree to enter into IP co-ownership arrangements, the contract will include a governance framework regulating the exercise of all relevant components of the IP and addressing the allocation of IP costs.
6. Where the IP is expected to generate commercial returns, we generally expect a reasonable and proportionate return in exchange for access rights.
7. We will retain sufficient intellectual property access rights to enable the conduct of further research in accordance with our charter.
8. We respect the IP of others but support the principle of exemptions for research use.
9. We will enforce our IPR and contractual rights in a manner consistent with our statutory charter and roles within the innovation system.
10. In the context of maximising the impact of our research efforts we will endeavour to ensure that intellectual property and knowledge is made available for humanitarian uses and the public good. In further developing these principles and related protocols we will seek to work with our national and global peers within the research community to promote a common approach to the management of intellectual capital.

### CSIRO Patent Portfolio and Licensing

CSIRO currently maintains 756 items of registered intellectual property, including 660 families of patents or patent applications, 90 Plant breeders Rights and 6 designs. CSIRO is one of Australia's largest filers of Australian provisional patent applications - CSIRO is responsible for over 3% of the patent applications under the PCT patent system, filed between 2006 and 2012 by first-named Australian applicants.

To put these figures into a context:

- The origin of the inventions is a key factor in the subsequent management of the intellectual property. Approximately 30% of these assets have arisen during research collaborations with other parties, be they industrial partners, government research institutes or university

collaborators. Where a commercial collaborator is involved during the conduct of the research, that collaborator will generally have either a licence, or first rights to take a licence, to use the intellectual property for commercial purposes;

- Considering the 660 families of patents or patent applications, 380 of these (58%) have arisen from science conducted by CSIRO where that science has not been funded by third party funds;
- In a competitive global field, it is often appropriate to make an application for patent coverage early after the initial discovery and demonstration of the invention. However it commonly takes many years to take an invention from its proof of concept stage to a commercially attractive technology. For these reasons, a patent portfolio is expected to include intellectual property for which licenses have not been entered;
- 280 patents (42% of all CSIRO's patents or patent applications) are the subject of a research use licence and 172 (or 26%) are the subject of commercial license rights. {There is some overlap in these license numbers because some of patents are licensed (non-exclusively) to a commercial partner, but are also subject to separate research license rights to develop up other applications, for example. This overlap is often the case where the patent covers "platform" intellectual property and so is non-exclusively licensed – for example, for different gene silencing applications};
- The CSIRO patent portfolio includes 380 patent/ patent application families which are not as yet licensed, 70% of this 380 being not as yet published through the patent system due to being inventions made in recent time periods (i.e. not available to the public as yet, but will be disclosed by the Patent Office as the patent application progress);
- Most of CSIRO's plant varieties are licensed (76 are licensed);
- CSIRO also maintains 230 trademarks, 20 of which are licensed;
- 58% of CSIRO's licensees (both from our registered IP assets and non registered rights) are Australian.

Recently, CSIRO has reviewed and streamlined its patent portfolio to include only significant or platform technologies. Following this, CSIRO still holds more than twice as many patent families in its

portfolio as the most patent-intensive Australian university.

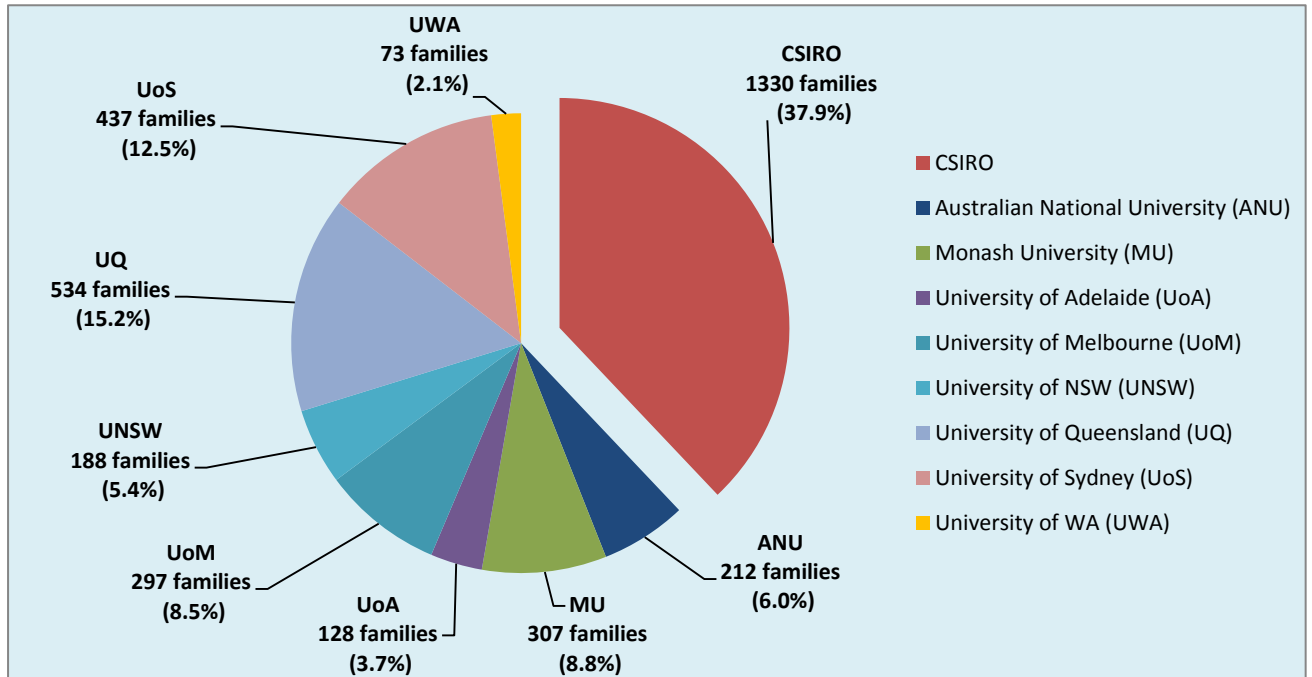


Figure 3: Australian generated patent families which have an EP, US or WO publication between 2000-01-01 and 2011-12-31<sup>xv</sup>

CSIRO maintains patent portfolio numbers that are comparable with the *aggregated* university patent portfolio (as reflected in the 2010 KCA Commercialisation Metrics Report). As described above, the recent decline in patent numbers held by CSIRO reflects a recent streamlining of CSIRO's patent portfolio:

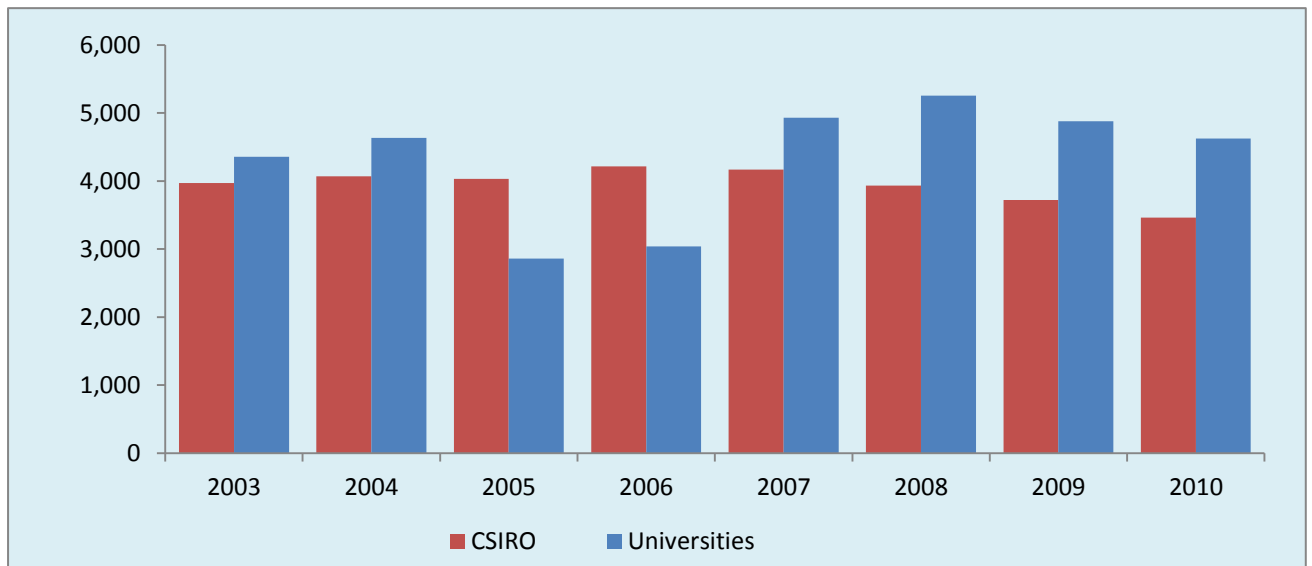


Figure 4: Australian patents held 2003-2010<sup>xvi</sup>

## Issues that arise:

Anecdotal evidence indicates that businesses, particularly small and medium sized firms, find the “national innovation system” complex to deal with for commercial arrangements. The reasons for this include that different organisations in the system currently adopt different policies and standards, ranging across commercial issues of the financial aspects of transactions, the respective responsibilities of the partners in managing risks and their control aspects during the commercial engagement, and the ownership of intellectual property, its management and use. To further confound these issues, there are varying degrees of capacity (time availability, specialist knowledge, and legal capability) in institutions and businesses to efficiently come to agreement on these issues.

On the issue of intellectual property, whilst it may be appropriate in some cases for approaches to the management of intellectual capital to vary from public sector research institution to institution, there are a number of common elements that are shared across the spectrum of institutions. It is CSIRO’s proposal that the Ten Principles reflected in the box would be an appropriate input to the development of a set of national principles for intellectual property management by public sector research institutions (to be implemented in association with the Statement of IP Principles for Australian Government Agencies).

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