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Submission to the South Australian Productivity Commission

Research and Development Inquiry – Issues Paper

11 June 2020

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RESEARCH AND DEVELOPMENT INQUIRY – ISSUES PAPER

The Australian Academy of Technology and Engineering (ATSE)[1] welcomes the opportunity to respond to the South Australian Productivity Commission's Issues Paper on the Research and Development Inquiry.

Research and development and their translation into practice are essential drivers of a country's economic growth and international competitiveness. Well-targeted R&D can generate economic, environmental and social benefits that far outweigh the investment. It is in the South Australian Government's interest to support (and jointly fund) R&D and the translation of its outcomes in order to achieve sustainable economic growth and prosperity for all South Australians.

In order for R&D to generate significant economic benefits it must:

a. be translated into new commercial processes, products and/or services

b. produce significant savings in current processes, or

c. provide increased levels of sustainability.

This requires close collaboration between research institutions, industry and government so that research outcomes can be commercialised and brought to market. The success of the Waite Precinct in Urrbrae provides an excellent example of how this collaboration can result in many outstanding outcomes. The Cooperative Research Centre Program provides another example of how this three-way collaboration in R&D can generate significant and enduring economic benefits.

There is evidence that the greatest economic return from expenditure on R&D comes from high growth firms (HGF). Other important factors are the presence of new firms in an industry and the presence of companies with large digital footprints. These three factors, together with collaboration between industry, research institutions and government, are the main elements that should be taken into account when deciding where to target SA's R&D resources.

Based on the above factors and knowledge of the research strengths in SA, ATSE has identified the following industry sectors as good candidates for R&D expenditure in SA:

1. Information and communications technology
2. Space
3. Renewable energy generation and storage
4. Mining
5. Agriculture and Marine Bioresources
6. Natural Resource Management

We present below a list of ten actions the SA Government can take to increase R&D activity in the state. A number of these are aimed at increasing R&D investment by industry or the Federal Government. ATSE believes these actions would increase the amount of R&D carried out in SA and result in significant economic growth, environmental and social benefits to the SA community.

[1] The Australian Academy of Technology and Engineering is a Learned Academy of independent, non-political experts helping Australians understand and use technology to solve complex problems. Bringing together Australia's leading thinkers in applied science, technology and engineering, ATSE provides impartial, practical and evidence-based advice on how to achieve sustainable solutions and advance prosperity.

The benefits of expenditure on research and development

Research and development (R&D) and their translation into practice are essential drivers of a country's economic growth and international competitiveness. According to the OECD, innovation accounts for around half of the total growth in GDP in OECD members over the long term (OECD, 2015).

The benefits of expenditure on research and development to the Australian economy have been widely documented. For example, a report commissioned by the Australian Department of Industry, Innovation, Science, Research and Tertiary Education (Allen Consulting Group, 2012) reviewed the benefits delivered by the translation of technologies, products and services from 117 Cooperative Research Centres (CRCs). This report identified almost $14.5 billion of direct economic benefits with a benefit cost ratio (B/C) of the CRC Program of 3.1 relative to the funds committed by the Australian Government. Furthermore, the report points out that this estimate doesn't include significant indirect economic benefits, environmental benefits and social benefits.

Other evaluations of the benefits of government and industry expenditure on R&D include:

- An analysis of 32 randomly selected projects from a portfolio of 600 funded by the Rural Industry R&D Corporation showed a B/C ratio of 11 (Rural R&D Corporation, 2008)
- Analysis of a range of water research programs (including two CRCs) with a total expenditure of $277.5M showed an average B/C ratio of 13.2 (Dillon et al, 2018)

How can South Australia's R&D funding be better targeted?

There is strong evidence that in order for R&D to generate significant economic benefits, it needs to: (a) be translated into new commercial processes, products and/or services; (b) produce significant savings in current processes; or (c) provide increased levels of sustainability. Close collaboration between research institutions, industry and government is required to commercialise and put into practice research outcomes. There are many examples of how this three-way close collaboration has resulted in significant benefits.

The Waite Precinct in Urrbrae (see **Appendix A**) is an excellent example. The precinct represents the greatest cluster of agricultural research in Australia, and has given rise to many important advances, including:

> *the development of barley and wheat varieties that contribute a major proportion of the national production of these crops, use of genomics to develop drought- and salt-tolerant cereal crops, breeding of more productive pulses, understanding of micronutrient deficiencies and toxicities, identification of the pathways for the synthesis of complex carbohydrates leading to opportunities to increase the nutritional value of cereal grains, and carbon dating of wines to confirm their year of production thus avoiding fraud.* (Zeitz, 2014)

The CRC program provides many examples of collaboration between research institutions, industry and government generating significant economic benefits from research. The estimated benefits of the CRC program by sector are (Allen Consulting Group, 2012):

- Agriculture $6150 million
- Services $5683 million
- Mining $1549 million
- Manufacturing $1068 million

There also is strong evidence that high growth firms (HGF) produce the greatest economic return from expenditure on R&D. According to the Department of Industry, Innovation and Science (DIIS, 2017) "Firms at the 90th percentile of the turnover growth distribution benefit by increasing their R&D

intensity (i.e. R&D expenditure divided by total turnover) about 13 times more than the median". However, high growth firms are not easy to identify. DIIS (2017) defines HGF as those that show an average annual growth in turnover or employment of more than 20 percent per year over three successive years.[2]

For the period 2004-5 to 2011-12, the largest number of HGF in Australia in both the employment and turnover growth categories had between 20 and 199 employees (Australian Bureau of Statistics, 2017). The highest proportion of HGF were in the construction and mining industries followed by the professional, technical and scientific services sector and by agriculture, forestry and fishing.

SMEs (small and medium enterprises – firms with 199 employees or less) report difficulty in identifying the type of research that might be of value to developing their products and markets, and to find appropriate collaborators. Similarly, researchers report difficulty in identifying appropriate SME partners. This hinders the growth of collaborative R&D between SMEs and research institutions and contributes to Australia's rank at the bottom of OECD nations on innovation and collaboration between industry and research.

ATSE recommends that the SA Government invests in supporting links between SA SMEs and researchers, particularly with respect to the sectors that offer the best opportunities for R&D growth in South Australia (see below). One such opportunity is the development of an interactive, online database in which SMEs and researchers can conduct keyword searches to seek out collaborative partnerships and enable R&D supported growth.

Another factor that is a strong indicator of likely increases in total jobs and economic growth is the presence of new firms in the industry. Hence, start-up companies in targeted industries should be strongly encouraged and, in fact, nurtured.

There is also a strong link between a company's digital footprint and its employment growth (DIIS, 2017). Therefore, companies with large digital footprints are more likely to be HGF. Consequently, R&D in the areas of information and communications technology (including machine learning, artificial intelligence and robotics) should be given high priority.

In summary, the following factors should be taken into account when deciding where to target SA's R&D expenditure:

1. Sectors which either already have strong links and a history of collaboration with research institutions and government or where that collaboration can be quickly achieved
2. Sectors with a large percentage of high growth firms
3. Sectors in which there is a significant number of start-up companies
4. Sectors with significant digital footprints or that have a focus on information and communications technologies.

Future Opportunities for R&D Growth in SA

Given the benefits to the state of expenditure on R&D, the question arises as to which industries offer the best opportunities for economic growth in SA arising from increased R&D expenditure.

[2] Only firms with five or more employees were included and the finance sector and non-market sectors were excluded in this assessment.

Based on SA's research strengths, and the need to satisfy one or more of the above factors, six industry sectors are presented here as good candidates for R&D expenditure in SA. They are:

1. Information and communications technology
2. Space
3. Renewable energy generation and storage
4. Mining
5. Agriculture and Marine Bioresources
6. Natural Resource Management

Each of these is discussed briefly below.

1. Information and communications technology (ICT)

Information and communications technology is arguably the key driver of productivity growth and innovation in the 21st century (Australian Academy of Technology and Engineering, 2020). ICT can contribute to innovations and increased efficiency in all of the industry sectors listed above through the application of artificial intelligence (AI) and autonomous systems, improved communications, data gathering, and machine learning. It can revolutionise our education systems, transportation systems and our work patterns, among others. It is an area of high growth and has a growing number of start-up companies including new business initiatives in cyber security and block chain financial systems.

2. Space

The Australian Space Agency has its headquarters in Adelaide. In addition, in 2016 there were 34 organisations involved in the space industry located in SA (South Australian Government, 2016). Adelaide is also the home of the SmartSat CRC (core partners include the Universities of South Australia and Adelaide, eight other Universities, Nova Systems, Airbus, BAE Systems, DST, Frontier SI, MDA and ULVAC). The SmartSat CRC has $255M in funding over seven years. Its main focus is on the application of satellite technologies to the areas of telecommunications, agriculture and natural resources, transport and logistics, mining, defence and national security. The SmartSat CRC has a number of start-up companies as partners.

3. Renewable energy generation and storage

SA is a leader in the use of renewable energy and energy storage. There is considerable scope for R&D in this field. There are also opportunities for demonstration projects in a range of renewable energy and storage technologies. The University of South Australia, the SA Department of Energy and Mining and SA Power Networks are partners in the RACE (Renewable Affordable Clean Energy) for 2030 CRC. Also all three SA Universities are involved in the Australian Solar Thermal Research Institute. Of particular interest is the field of hydrogen production and storage. The widespread availability of renewable energy (primarily solar and wind) enables the production of green hydrogen that can be used as a fuel for transport, blended with natural gas, used as a means of storing energy or exported. Japan and South Korea are rapidly developing hydrogen-based economies and actively seeking to identify countries that can help them to meet their future demand for hydrogen.

4. Mining

SA has the largest concentration of university-based mining R&D in Australia, currently committed to various research centres and projects, all of which have active industry engagement. The details of these are given in **Appendix B**. For example, the SA Department for Energy and Mining, the University of South Australia (UniSA) and the University of Adelaide are partners in the MinEx CRC, which is co-headquartered at UniSA. This is the world's largest mineral exploration collaboration involving industry, government and research organisations with a budget of $218M (cash and in-kind). Many of

the current and recent mining projects in SA involve the active participation of Mining Equipment, Technology and Services (METS), which is one of the Federal Government's six Industry Growth Centres in sectors of competitive strength and strategic priority. This concentration of research activity offers significant research translation opportunities for METS companies and provides an opportunity for METS companies to establish a presence in SA.

5. Agriculture and Marine Bioresources

Under the National Research Development and Extension Framework (R,D&E Framework) agreed between Commonwealth and States' Ministers of Agriculture/Primary Industries, South Australia is defined as a major research resource in cereals, wild fisheries, aquaculture, pigs, poultry, viticulture and wine. As a result of extensive R&D, food products in these areas form prime SA export industries. These industries, given ongoing R&D at appropriate levels, have considerable future growth and export potential and should be strongly supported. The R,D&E Framework also recognises SA's major R&D strengths in the underpinning areas of water use in agriculture, climate change, variability and adaptation, and in plant pathology and plant diseases. There are opportunities to strengthen R&D collaboration between the food sector and nutrition-related components of the health sector to maximise the potential efficiency and product quality gains in the whole food chain. Such collaboration should be supported and be based in SA between the recognised agricultural research institutions and the private sector.

South Australia is currently leading (hosting) the development of a CRC in Marine Bioproducts (www.mbcrc.com). This application addresses key outcomes of 1) SA national leadership of a truly high potential (HG) industries/enterprises, 2) scaled national and global collaborations, 3) R&D institutions and industry partnerships and research results/products translation and 4) will result in South Australia (Flinders University) hosting a next generation industry CRC.

6. Natural Resource Management

Natural Resource Management (NRM) is the integrated management of the natural resources that make up Australia's natural landscapes, including land, water, soil, plants and animals. Key South Australian industries (including agriculture, mining and tourism) directly rely on these resources for their productivity, prosperity, resilience and intergenerational sustainability. NRM R&D is focused on developing an understanding of complex biosystems as well as scenario planning and informing policy makers and the community. This requires a systems (landscape/catchment) approach and involves collaboration between government, research organisations, the private sector and the community. R&D in NRM is essential in order to manage, maintain, enhance and (if necessary) remediate these resources and to maintain the strong environmental profile of SA.

Actions SA could take to increase R&D investment in the state:

There are a number of actions that the SA Government could take to increase the level of R&D investment and activity in the state. Based on the issues explored above, ATSE recommends that these include the following:

1. Encourage the Federal Government to broaden and enhance the R&D Tax Incentive scheme.
2. Provide tax concessions for companies with high growth and/or a high level of R&D to set up or relocate to SA.
3. Provide significant financial and in-kind support for CRC bids that plan to have their headquarters in SA.
4. Set targets for Government Departments' and Corporations' expenditure on R&D. This would include contributions toward Cooperative Research Centres and co-funding collaborative R&D

projects between industry, universities, and other research organisations in the targeted areas. A typical expenditure on strategic R&D in strong economies is 2% to 4 % of revenue and up to 12% in high technology sectors.

5. Increase investment in the SA Research, Commercialisation and Startup Fund (SARCSF).
6. Ensure that priority for funding from the SARCSF is given to partnerships of industry, universities and research institutes. This will leverage funding from these other bodies as they provide matching funding.
7. Develop a marketing campaign based on SA's COVID-19 response and the benefits of living in a vibrant, innovation-friendly, clean and green city to attract young entrepreneurs and researchers to SA.
8. Provide support for the development of an interactive online database in which small and medium enterprises (SMEs) and researchers can find each other and develop collaborative partnerships in the applications of R&D. This particularly applies to the sectors that offer the best opportunities for R&D growth in South Australia (outlined above).
9. Increase investment in research Institutes such as the Goyder Institute for Water Research that facilitates matching funding from CSIRO and the three universities in SA.
10. Co-fund full-time research positions in the priority fields in SA Universities.

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Appendix A: The Waite Research Precinct

The Waite Precinct houses the following organisations: The Waite Research Institute (University of Adelaide), CSIRO, the Australian Wine Research Institute, SARDI, the Australian Centre for Plant Functional Genomics, the Australian Genome Research Facility, the Australian Grain Technologies, FoodPlus Research Centre, the Australian Plant Phenomics Facility and the Wine Innovation Cluster.

Key commercial and international partners include The Mosaic Company (fertiliser research), Viterra, Carlsberg, Sapporo, Sanwa and Heineken (barley breeding and malting), Pioneer-DuPont, and Monsanto (grains research), and numerous wine companies from both Australia and overseas. Industry-focused research is also funded by the Grains Research and Development Corporation (GRDC), the Grape and Wine RDC, and several other levy-funded bodies.

Appendix B: Current mining R&D centres and projects in SA

Current Mining R&D Centres and Projects in SA include the following:

1. MinEx CRC (University of South Australia, University of Adelaide, DEM), co-headquartered at UniSA; $218M cash and in-kind
2. The PRIF Research Consortium for Unlocking Complex Resources through Lean Processing (Adelaide, UniSA, BHP, OZ Minerals and 15 METS companies); $14.6M cash and in-kind.
3. ARC Industrial Transformation Training Centre for Integrated Operations for Complex Resources (Adelaide, UniSA, Curtin, BHP, OZ Minerals, 15 METS companies and five other organisations); $3.7M cash from the ARC plus $2.0M cash from partners and $6.8M in-kind.
4. ARC Copper Uranium Research Hub; $11.6M.
5. Co-operative Research Centre Project (CRC-P) Kapunda In-Situ Copper and Gold Field Recovery Trial; $2.85M
6. CRC ORE Upconversion fluorescence facility and cross-belt fluorine mineral sensor $2M.
7. AMIRA P260, a continuous ‘family’ of projects since 1988 with over 100 mining, engineering and SME supply-chain suppliers participating to date
8. CRC-P for Wear Life Extension Via Surface Engineering Laser Cladding for Mining, $8.3M

ATSE is grateful for the support and advice of the following working group of ATSE Fellows:

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Further information

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