



Australia's National  
Science Agency

# The Australian Manufacturing Industry

Senate Standing Committee on  
Economics

CSIRO Submission 21/764

September 2021

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## Introduction

The Commonwealth Scientific and Industrial Research Organisation (CSIRO) welcomes the opportunity to provide input to the Senate Standing Committee on Economics Inquiry into the Australian manufacturing industry.

This submission provides an overview of CSIRO's engagement with the Modern Manufacturing Strategy (MMS), our commercialisation approach and outlines the work and research undertaken by CSIRO to support the Australian manufacturing industry.

## Modern Manufacturing Strategy

CSIRO is a strong supporter of the Australian Government's National Manufacturing priorities and the MMS. We believe our science, research and innovation capabilities are critical enablers of transformation in manufacturing.

At present, CSIRO is working to support several key industry-led bids through the Modern Manufacturing Initiative, the centrepiece of the MMS. These bids are all aligned with CSIRO's strategic priorities and capabilities, including bolstering Australia's COVID-19 recovery, building resilience, and providing practical science and technology solutions to support and enable key priority sectors identified by the Government. The bids are also directly aligned to several national challenges outlined by CSIRO including future industries, sustainable energy and resources and food security and quality. If these bids are successful it will lead to CSIRO providing scientific capabilities and expertise to the selected recipients.

## Our Commercialisation Approach

Under the *Science and Industry Research Act 1949*, one of CSIRO's primary purposes is to facilitate and encourage the adoption and utilisation of scientific research for the benefit of Australia, including to create jobs and economic benefit.

Through collaboration with industry, universities and other organisations, CSIRO has 40 active investee companies with a market capitalisation worth over \$3 billion. These companies have an annual revenue of \$95 million and have more than 850 employees. CSIRO has an intellectual property portfolio of over 450 active licenses, of which 300 have generated royalty payments.

This investment flows through to the Australian manufacturing industry. For example, in Victoria, our world-class Lab 22 works with Australian companies to make metallic additive manufacturing technologies more accessible.

# Science and Technology Supporting the Australian Manufacturing Industry

In preparing this response, CSIRO draws your attention to a 2020 report entitled *COVID-19: Recovery and resilience*. The report, authored by CSIRO, highlights growth opportunities for the Australian manufacturing industry by utilising new technologies. The report has a short horizon, looking for opportunities through to the end of 2022.

CSIRO also publishes industry roadmaps – an analysis of future trends in a range of industries. The roadmaps are designed to identify future growth opportunities, using science and technology, for Australian industry. A range of roadmaps produced by CSIRO are summarised including:

- Critical Energy Minerals Roadmap
- Australia's Synthetic Biology Roadmap
- Growing Australia's Quantum Technology Industry
- Victoria's Nutraceutical Industry
- Food and Agriculture Roadmap and Growth opportunities for Australian food and agribusiness.
- Space Roadmap
- National Hydrogen Roadmap
- Mining Equipment, Technology and Services Roadmap
- Cyber Security Roadmap
- Low Emissions Technology Roadmap
- Medical Technologies and Pharmaceuticals Roadmap

Finally, the *Australian National Outlook 2019* combines CSIRO's integrated modelling and research with input from National Outlook participants, a group comprised of over 50 leaders across 22 leading Australian organisations from industry, the not-for-profit and education sectors, to provide a compelling view about Australia's future.

CSIRO would be happy to provide further information on these reports if requested by the committee.

## COVID-19: Recovery and resilience

**Published:** 2020

**Report:** [COVID-19: Recovery and resilience - CSIRO](#)

CSIRO has been supporting Australia's response to COVID-19. This work has included guiding the public health response and virus suppression, treatment, and testing. For example, work carried out by the Australian Centre for Disease Preparedness contributed to global efforts to find a COVID-19 vaccine.

This report shows how CSIRO's work can extend to the economic recovery phase of the pandemic. Highlighted in the report is the importance of a modernised manufacturing sector to generate economic growth opportunities. The report also identified several trends, national advantages and medium to long-term opportunities for Australian manufacturers.

### Trends

- **Agile and bespoke solutions**  
Advanced additive manufacturing, materials and digital design and controlled processes are enabling the production of bespoke solutions. The ability to adapt and pivot production locally to react to changing supply needs will become more important, prompting a new look at how to integrate more advanced design and build technologies into the production line.
- **Sustainable operations**  
Resource scarcity, climate change and community expectations are driving a move to sustainable operations. This continues to be a high priority for government and industry. With a renewed interest in local manufacturing, traceable and sustainable processes and operating models will be critical.
- **Data capture and analytics**  
Maximising efficiency and connectivity will remain important during and following the pandemic. The convergence of technologies like sensors, automation, intelligent robotics, embedded electronics and their internet connectivity will drive optimised operations and trusted supply chains.

### National Advantages

- **Quality and standards**  
Australia has a strong reputation for quality and safety. In a time when exported products and services are coming under more intense scrutiny, and there is greater demand for supply chain integrity, Australia can further leverage this advantage to sell its trusted premium goods and services to the world.
- **Education and research skills**  
This is a relatively untapped advantage at present. Many of the best graduates choose career pathways outside of manufacturing. The disruption caused by COVID-19 provides an opportunity for business to co-design programs for students to gain industry experience and exposure to manufacturing.

- **Small and medium enterprises**

Being flexible in an uncertain economic environment is critical. Most Australian manufacturers are small and medium-sized enterprises (SMEs). They are well placed to be responsive to global demand changes through the application of innovation.

### Opportunities

- **Maximisation of local manufacturing capabilities**

Local manufacturing is a cross-cutting capability that can be expanded to add value to Australia's growth sectors. Examples include developing Australia's aerospace industry which will build local manufacturing jobs across the value chain, including for aircraft components, miniaturised spacecraft, object tracking and earth imaging technologies.

Similarly, manufacturing can be used to develop technologies that support the Australian Defence Force which will expand local manufacturing jobs and support sovereignty and self-sufficiency.

Current product offerings can also be further enhanced to provide additional services, such as incorporating sensors into mining or medical equipment.

- **Superior componentry**

The production and integration of advanced materials will be key to the development of new high-value manufacturing sectors. Opportunities include developing specialised components with unconventional and new feedstocks like lightweight materials, biological materials, pharmaceuticals and the printing of prosthetics, dental and bone implants.

- **Sustainable and agile manufacturing**

Moving toward closed loop systems with re-cycle, re-use and re-manufacturing principles will enable Australia to offer traceable premium green products and reduce reliance on imported critical parts and materials. The ability to use smart and flexible, digitised manufacturing will also allow manufacturers to pivot their production lines to meet supply shortages in the short-term and then revert production once the shortfall has been met.

- **Value-adding downstream processing of minerals**

By adopting advanced processing and refining, Australia can increase the economic value of its minerals prior to their export, producing refined metals, pre-cursor chemicals, alloys and high-end engineered products. This can create high-technology jobs and industries, strengthen supply chain sovereignty, and lower the environmental impact of mined resources.

## Advanced Manufacturing Roadmap

Published: 2016

Report: [Advanced Manufacturing Roadmap - CSIRO](#)

The *Advanced Manufacturing Roadmap* was published in 2016. It has a 20-year vision to transform Australia's manufacturing industry into a highly integrated, collaborative and export-focussed ecosystem that provides high-value customised solutions within global value chains.

Page IV of the *Advanced Manufacturing Roadmap* states:

*Australian manufacturing can and must be a thriving component of Australia's economy through the application of advanced manufacturing technologies, systems and processes. The sector will focus on pre-production (design, R&D) and post-production (after-sales services) value-adding, sustainable manufacturing and low volume, high margin customised manufacturing.*

The roadmap identified 8 comparative advantages and 10 comparative disadvantages faced by Australian manufacturers

Comparative Advantages	Comparative Disadvantages
Education and research skills	High labour costs
Quality and standards	Geographical remoteness
Small and medium enterprises	Small and dispersed domestic market
Access to Asia	Risk adverse culture
Early Adopters	Segregated national agenda
Political and economic stability	Commercialisation
Natural resources	Staff training and development
Intellectual property laws	Digital infrastructure
	Public perception
	Quality and quantity of leaders

The roadmap also identified opportunities for growth including customised high-margin solutions, sustainable manufacturing and selling services.

## Critical Energy Minerals Roadmap

**Published:** 2021

**Report:** [Critical Energy Minerals Roadmap - CSIRO](#)

Global demand for renewable and low emission technologies continues to grow, as does demand for the critical mineral resources required to manufacture these technologies.

CSIRO believes Australia is well positioned to seize opportunities in this energy transition and respond to critical mineral demand. High value exports from critical energy metals can provide an important source of economic growth for Australia and help to power a global transition towards zero emissions.

The Critical Energy Minerals Roadmap outlines opportunities in how we can extract new value from our mining and manufacturing sectors.

## Australia's Synthetic Biology Roadmap

**Published:** 2021

**Report:** [Australia's Synthetic Biology Roadmap - CSIRO](#)

Published in August 2021, Australia's Synthetic Biology Roadmap estimates that synthetic biology has the potential to unlock \$27 billion in annual revenue and 44,000 jobs in Australia by 2040.

Australia has a growing synthetic biology research base and an attractive business environment for international partnerships. We can play a leading role in servicing the growing Asia-Pacific market for synthetic biology-enabled products.

Developing a national synthetic biology ecosystem could also help to establish cost-effective domestic manufacturing capabilities for supply chain resilience.

## Growing Australia's Quantum Technology Industry

**Published:** 2020

**Report:** [Growing Australia's Quantum Technology Industry - CSIRO](#)

Commercialising quantum technologies could create an \$86 billion global industry by 2040. Australia has world-class quantum research capabilities and an emerging quantum technology industry underpinned by the expertise and intellectual property developed in its research institutions.

These game-changing quantum technologies are poised to revolutionise a range of industries including manufacturing (e.g. in areas of precision manufacturing).



## Victoria's Nutraceutical Industry

**Published:** 2020

**Report:** [Victoria's Nutraceutical Industry - CSIRO](#)

Thirty three percent of Australia's vitamin and manufacturing establishments are in Victoria.

This report aims to help senior decision makers across industry and government identify growth opportunities that Victoria can pursue. These opportunities outline areas for investment, including supply chain gaps, that present potential new revenue streams for Victoria's primary production industry and new product innovation prospects that are driven by global industry trends.

While the report focuses on Victoria and its competitive advantages, the nutraceutical value chain often crosses state (and national) borders, with many of the growth opportunities applicable Australia wide.

## Food and Agriculture Roadmap and Growth opportunities for Australian food and agribusiness

**Published:** 2017 (Food and Agriculture Roadmap), 2019 (Growth opportunities for Australian food and agribusiness)

**Report:** Food and Agribusiness Roadmap: unlocking value-adding growth opportunities for Australia - CSIRO

Growth opportunities for Australian food and agribusiness: Economic analysis and market sizing - CSIRO

CSIRO produced the *Food and Agribusiness Roadmap* in July 2017 to support the Australian food and agribusiness industry in its transition to a collaborative, growth oriented, high value-adding and differentiated sector. The roadmap discussed industry trends and opportunities, and identified key science, technology and business enablers.

*Growth opportunities for Australian food and agribusiness* reflected on the 2017 *Food and Agribusiness Roadmap*. The report looked at how the adoption of organic waste conversion processes and technologies within the agriculture and food manufacturing industry has the potential to generate strong economic and environmental benefits. On page 20 the report states:

*Australian agriculture and fisheries currently produce about 16M tonnes of organic waste annually. While about half of organic waste produced today is recycled, CSIRO analysis estimates that halving landfilled organic waste through conversion by 2030 could recover \$400M in wholesale revenue of secondary materials.*

*This would contribute to the Australian Government's National Food Waste Strategy to halve food waste by 2030, and create annual net carbon emissions, electricity and water savings in the range of \$600M by 2030.*

## Space Roadmap

**Published:** 2018

**Report:** [Space Roadmap - CSIRO](#)

This Space Roadmap introduces opportunities for growth and differentiation based on Australia's natural advantages and leveraging our established industries to repurpose for space – like new materials, mining to extract water, oxygen and inks to print spare parts, agriculture to grow food in inhospitable terrain, space object tracking, and space exploration and utilisation. It goes on to identify enablers for unlocking these opportunities.

On page 21 the roadmap also discusses opportunities for advanced manufacturing facilities noting:

*a thriving new space industry based on miniaturised spacecraft, sub-systems and novel launch technologies requires flexible, comprehensive and cutting-edge manufacturing facilities for development, testing and scale-up.*

## National Hydrogen Roadmap

**Published:** 2018

**Report:** [National Hydrogen Roadmap - CSIRO](#)

The Hydrogen Roadmap set out a strategy for turning the emerging technologies that underpin a hydrogen economy into bankable assets, as a foundation for building an economically sustainable industry in Australia.

The report considered the full scope of potential applications for hydrogen including electricity/energy storage, heat, transport and industrial uses. CSIRO undertook detailed techno-economic assessments for each application for hydrogen. This, combined with broad stakeholder consultation and strategic analysis, was then used to develop an investment framework that outlined the commercial models, policy/regulations and RD&D investment required to allow hydrogen utilisation to become competitive in local and global markets.

Stated on page 3 of the roadmap:

*Australia has an established manufacturing base and expertise in high value or advanced manufacturing production processes. Given the global hydrogen industry is still in a development phase, many global technology manufacturers are yet to establish large scale operations and retain flexibility in selecting where to deploy production facilities.*

*Australia therefore remains an attractive investment proposition due to this and other factors such as government stability and the availability of land and natural resources. Our comparative disadvantage is the cost of labour. However as demand for hydrogen continues to grow, this disadvantage could be overcome through the implementation of automated production lines. Domestic manufacture could see the emergence of new local industries and potential for technology export to Asia.*

## Cyber Security Roadmap

**Published:** 2018

**Report:** [Cyber Security Roadmap - CSIRO](#)

This roadmap was designed to provide a vision for the cyber security industry – a globally competitive Australian cyber security that enables Australian organisations to pursue digitally driven growth.

The roadmap looks at the opportunities for growth in the Australian advanced manufacturing industry. The roadmap notes on page 49:

*Changing demographics, rising incomes and greater customer expectations are driving an opportunity for Australian manufacturers to develop services that provide customised and personalised products which can fetch higher margins. Integrating suppliers and customers into the design and production process can help to develop loyalty and stronger market insights, and hence a greater value proposition.*

*The value that is generated by advanced manufacturing outputs is apparent within many industries, which makes it an industry horizontal similar to cyber security. This opportunity focuses on customised manufacturing solutions that return value for high-technology industries such as medical technologies, defence and aviation. The opportunity to manufacture customised solutions is driven by a desire for these industries to procure very specific products or components, based on personal information, protected designs or confidential 'one-off' sets of information.*

*The development of manufacturing services that deliver customised products provides manufacturing businesses with an effective way to supply highly-differentiated solutions that have significantly greater value for their customers. For the foreseeable future, customised high-value manufacturing will allow for larger profit margins across the entire value chain: from research and development to after-sale services and end-of-life management. These solutions are typically delivered in markets where quality factors are valued over cost.*

The roadmap also identified that 16 percent of manufacturing businesses in Australia have experienced an internet security incident or breach.

## Mining Equipment, Technology and Services Roadmap

**Published:** 2017

**Report:** [Mining Equipment, Technology and Services Roadmap - CSIRO](#)

Australia's Mining Equipment, Technology and Services (METS) sector has an important role to play in the continued success of Australia's mining industry. However, the mining industry's increasing dependence on specialist technologies, combined with global mining megatrends, is creating new opportunities and threats for the future of Australia's METS sector.

The sector's comparative advantages could be lost if not nurtured, while its current disadvantages could become advantages if prioritised. A changing business environment and evolving market also creates support for a range of new business models.

The roadmap highlights on page 52 that:

*As highlighted in CSIRO's Advanced Manufacturing Roadmap, developing complementary service offerings is a key opportunity for growth for Australian manufacturers. For example, aircraft engine manufacturers have been offering performance-based service and logistics agreements to customers for decades. These services involve a fixed warranty and operational fee for the hours engines are running, meaning that in addition to making the product, the manufacturer takes care of installation, after-sales maintenance, repair, overhaul and overall service and parts management.*

## Low Emissions Technology Roadmap

**Published:** 2017

**Report:** [Low Emissions Technology Roadmap - CSIRO](#)

The Low Emissions Technology Roadmap, in part, assessed how low emissions technologies can create new growth opportunities for Australian industries. From a manufacturing perspective several opportunities were identified including:

- The manufacturing of specialised components such as heliostats for the domestic market and for export.
- Opportunities for innovative Australian companies to develop new products and services such as energy management systems.
- The potential for Australia to expand its participation in the global nuclear supply chain by further developing advanced manufacturing capabilities for the supply of specialised components.

## Medical Technologies and Pharmaceuticals Roadmap

**Published:** 2017

**Report:** [Medical Technologies and Pharmaceuticals Roadmap - CSIRO](#)

This roadmap advocates that the medical technologies and pharmaceuticals industry will rest on four main sectors, including the manufacturing and high-value pharmaceuticals sector. The vision for manufacturing high-value pharmaceuticals, as stated on page VII of the roadmap is:

*to focus Australian manufacturing efforts toward high-value and niche pharmaceutical products that create sustainable export revenue. Australia can leverage advantages around ingenuity, quality and reliability to attract businesses without the capacity to develop complex production processes in-house. This would see an increase in the number of local development teams required to manufacture products for direct export or clinical development.*

A key outcome from realising this vision would be the development of novel drug delivery and manufacturing technologies; Australian based contract manufacturing and development of biologics, biosimilars and other complex products for global multinationals, with a focus on distribution in Asia.

The roadmap further identifies an opportunity to create an industry strength in designing, testing, and manufacturing communicative and responsive devices, bionics and personalised implants for export.

## Australian National Outlook 2019

**Published:** 2019

**Report:** [Australian National Outlook - CSIRO](#)

This report, completed in conjunction with the National Australia Bank, reiterated many of the manufacturing opportunities highlighted in the roadmaps discussed above. This includes medical device manufacturing, additive manufacturing, food manufacturing and the development and manufacture of hydrogen technologies.

## List of Research

1. CSIRO Futures (2020) COVID-19: Recovery and resilience, CSIRO, Canberra.
2. CSIRO Futures (2016) Advanced Manufacturing: A Roadmap for unlocking future growth opportunities for Australia, CSIRO, Canberra.
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