

**Flinders University**  
Australian Industrial  
Transformation  
Institute

**MANUFACTURING TRANSFORMATION**  
High value manufacturing for the 21<sup>st</sup> century



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# **MANUFACTURING TRANSFORMATION**

**High value manufacturing for the 21st century**

# Australian Industrial Transformation Institute

College of Business, Government and Law  
Flinders University of South Australia

1284 South Road  
Clovelly Park  
South Australia 5042

[www.flinders.edu.au/aiti](http://www.flinders.edu.au/aiti)

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## Foreword

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The prosperity and high living standards we enjoy today were won through industrialisation. Over the 20<sup>th</sup> century, through wars, depression and a later boom, Australia diversified its economic base to overcome limitations placed on its development by excessive reliance on exports of unprocessed agricultural and mineral commodities. We sought to add value to these raw materials through a domestic manufacturing sector. At the dawn of the 21<sup>st</sup> century we face the challenge of re-industrialisation, a deliberate strategy to accelerate the growth of high value manufacturing companies and jobs. While Covid-19 has reminded us how critical it is to have robust and adaptable manufacturing supply chains during periods of crisis we need to rediscover why manufacturing is always strategically important to Australia.

Over the past 25 years especially, Australian manufacturing has been in decline almost continuously. This has been most pronounced since 2008, when the mining boom started to drive the Australian dollar to uncompetitive levels. Not only relative declines in manufacturing's shares of total employment and Gross Domestic Product (GDP) but also absolute falls in manufacturing output and employment have marked the past decade. The resulting changes now reveal Australia with an economic structure similar to that of a third world country. We have in certain respects fallen back to where we were a century ago – an exporter of low value raw materials and commodities to industrial countries.

The flipside of this profile as a raw materials exporter is that Australia is a hungry importer of other nations' high-end knowledge-intensive manufactures. One of the many potential benefits of manufacturing that Australia has denied itself is 'economic complexity' – the whole range of knowledge-intensive activities, and the capacity for innovation, that cluster around domestic manufacturing especially.

Australia has been lucky, but we cannot face the future without a long-term industrial transformation strategy that drives the growth of sustainable, high value manufacturing and jobs. The Australian Government is providing support directly to companies through the Modern Manufacturing Initiative (MMI) including substantial funding for high impact collaborations involving companies and universities. While this is welcome, the MMI falls short of the longer term strategy and commitment to co-investment required to accelerate the growth of high value manufacturing and high skill jobs.

The pandemic showed Australians just how vulnerable the nation is when threatened with disruptions to import supply chains, serious gaps were revealed in our capacity to produce even basic protective equipment. If, on the positive side, the pandemic provided instances of agility and rapid adaptation to meet urgent needs of the population, it also revealed gaps in our capacities and capabilities to make many of the things we need to be able to.

Today many advanced economies are using lessons from the pandemic to re-evaluate past policies, and to reconsider roles for government and industrial policies in setting positive directions, and catalysing economy-wide partnerships for inclusive growth and greater national sovereignty and security.

Australia needs a comprehensive and ambitious post-pandemic national industrial strategy – a strategy for reindustrialisation that responds to sovereign capability and sustainability objectives. Australia is at a crossroads between continued overreliance on declining forms of resource extraction and vulnerability to uncertain supply chains, versus a more balanced

economic portfolio that includes greater domestic production of our own requirements, more Australian value-adding to our minerals and more knowledge-intensive industries and products, more and better jobs with fairer distribution of the benefits of overall economic growth, realising the economic gains from decarbonisation, and greater national sovereignty and self-reliance.

Some will say industrial policy is anti-trade and anti-competitive. But policies relying on tariffs died out decades ago and today, Australia has one of the least protected home markets in the developed world. The industrial strategy advocated here would not restore zero-sum barriers to trade but instead take the high road of innovation and long-term investment and, in fact, promote greater involvement in global value chains (GVCs).

*Manufacturing Transformation* makes the case for Australia's industrial transformation and a just transition for the Australian workforce. It recommends actions critical to that goal, including:

- Developing a National Industrialisation Strategy under the leadership of a National Industrialisation Commission
- Better using the purchasing power of Australian governments to develop innovative products and processes and new industries through advanced procurement
- Establish a network of high value 'Catapult' centres across Australia led by University's in collaboration with industry
- Measures to build research collaborations that become new products and innovations
- Building complex knowledge-intensive industries off existing strengths
- Onshore processing of our immense mineral wealth as a major plank of reindustrialisation
- Utilising the great opportunities for new industries from the delayed but inevitable decarbonisation of our economy
- Positively leveraging the circular economy for the great industrial opportunity that it is
- Measures to encourage manufacturing investment to the areas of vast future opportunity
- A workforce strategy that supports a just transition for Australian workers impacted by industrial transformation imperatives.

Bridging the gap between our current position and the better future that is possible starts with the commitment to a comprehensive national strategy for industrial transformation. This commitment would place us in a position closer to, and not in contradiction with, the directions now being adopted by other advanced economies.

*Manufacturing Transformation* has been prepared by the Australian Industrial Transformation at Flinders University to help stimulate debate about strategies for accelerating the growth of high value manufacturing and jobs in Australia. A new consensus about the central importance of manufacturing in Australia needs to be forged. We hope that this report makes a modest contribution to that objective. I am grateful to Lance Worrall and Hamish Gamble who assisted with the preparation of this report.

**Professor John Spoehr**  
**Director**  
Australian Industrial Transformation Institute

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## Abbreviations

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FDI	Foreign Direct Investment
GDP	Gross Domestic Product
GNI	Gross National Income
GVC	Global Value Chain
MNC	Multinational Corporation
NIS	National Industrial Strategy
NISC	National Industrial Strategy Commission
OECD	Organisation for Economic Cooperation and Development
R&D	Research and Development
SME	Small and Medium Enterprises

# 1 Australia at a crossroads

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Australia has a choice to make. We can remain over-reliant on bulk exports of raw minerals and materials, allowing a growing share of value adding activities to occur offshore, making us increasingly vulnerable to external shocks and instability. Or we can adopt a more hopeful path. This means a strategy to compete on something beyond price, and supporting the development of industries, firms and clusters that invest in the workforce, research and development, value sustainability, and drive quality. As well as accelerating the adoption of advanced technologies and high-performance workplace practices, a 21<sup>st</sup> century re-industrialisation pathway means greater investment in people and 'intangibles' like organisational innovation and new business models. This means realigning incentives to discourage short-termism and encourage innovation and value-adding by private businesses. This requires the development of a re-industrialisation strategy that seeks to dramatically transform Australia's industrial structure to deliver rewarding jobs in productive modern companies.

Recovery from Covid provides the perfect opportunity for a transformative agenda. Transforming Australia's industrial base will create high paying and more secure jobs, strengthen our engagement in global supply chains while increasing our economic self-reliance, and strengthen the economy against future economic shocks. It will require conviction by Government and policy makers, and the active involvement of industry, trade unions, universities, and the research sector.

Australia has been on the path of deindustrialisation for the past quarter century. This was not inevitable. More than many people think, it was the cumulative result of policy decisions to reject the concept of industrial policy and strategy. Industrial policies of the time were replaced by comparative advantage ideologies that said our economy should concentrate on its natural resources and be guided by freer markets and relative price signals. Policies that favoured particular sectors were unwound, and the idea of an industrial strategy was misrepresented as inherently anti-trade and anti-competitive. At most, generic business support policies were acceptable. The only exception to this has been the defence industry which, on national security and sovereignty grounds, has been deemed worthy of a dedicated sectoral plan. Elsewhere the emphasis has been on 'business support' limited to generic issues across all industries such as addressing market failures and easing the cost of doing business.

The manufacturing workforce in Australia once made up almost 30% of the total workforce, and contributed almost 30% of Australia's Gross Domestic Product (GDP)<sup>1</sup>. Today employment stands at only 6.9% and the contribution of manufacturing to the economy is about 6%. As a result, Australia is now the least self-sufficient country in the OECD for manufacturing. This is to say, Australia produces the lowest proportion of its own domestic requirements for consumption of manufactures of any OECD country. Table 1 shows the level of manufacturing dependency for 8 selected OECD nations, together with the share of GDP represented by their manufacturing sectors. Australia ranks last on self-sufficiency in this selection (as it does for the entire OECD) and second last in manufacturing as a proportion of

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<sup>1</sup> Australian Treasury (2019); Connolly and Lewis (2010)

the national economy (within the OECD only the tiny nation of Luxembourg has a smaller manufacturing sector).

**Table 1: OECD manufacturing dependency, selected countries, 2015, and manufacturing GDP share, 2019**

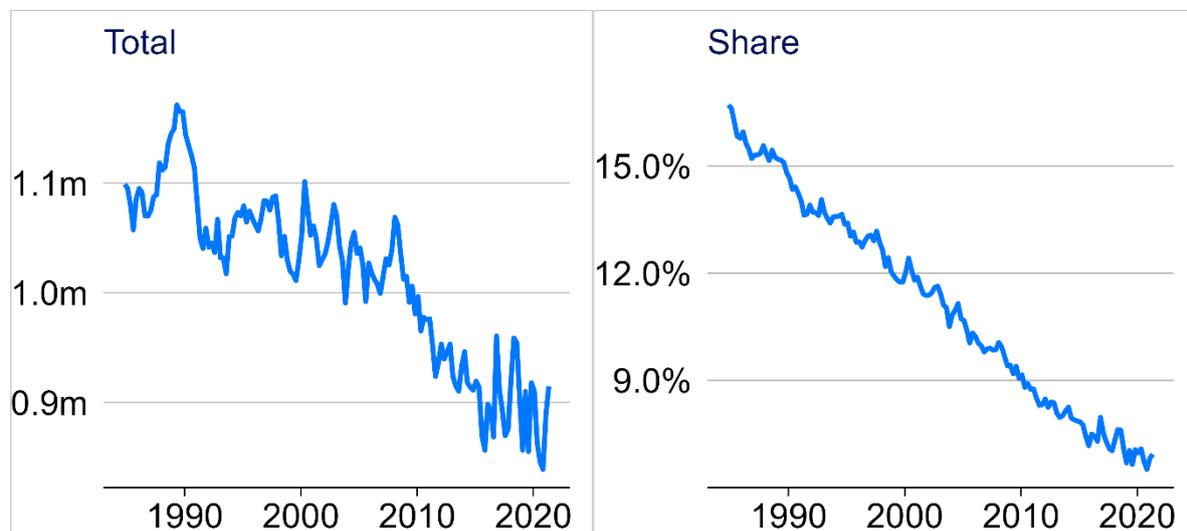
Country	Gross Manufacturing Output (\$US b)	Ratio of Manufactured Imports/Exports	Manufacturing Trade Balance (\$US b)	Self-Sufficiency Ratio	Rank	Manufacturing GDP Share (2019)
Germany	2013.9	0.6	347.1	120.8%	2	19
Korea	1467.0	0.6	227.4	118.3%	5	25
Sweden	203.0	0.8	21.8	112.0%	8	13
Japan	2616.5	0.8	115.8	104.6%	18	21
Israel	110.4	0.9	2.9	102.7%	20	11
U.S.	5744.5	1.8	-711.4	89.0%	29	11
Canada	596.0	1.4	-74.4	88.9%	30	10
Australia	269.2	2.8	-107.2	71.5%	36	6
OECD average	-	-	-	-	-	13

Source: Stanford (2020) and The World Bank (2021).

## 2 Why Australia needs an industrial strategy

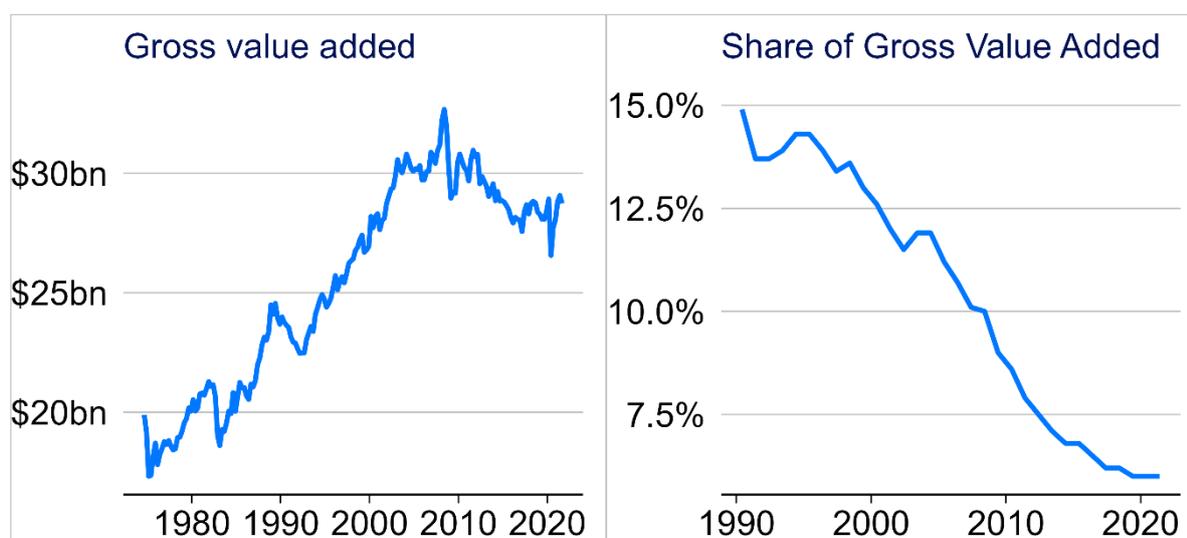
Relative to its economy or GDP, Australia has the second-smallest manufacturing sector of any OECD nation. Only the tiny tax haven of Luxembourg has a lower manufacturing share. At about 6 percent of our GDP, manufacturing in Australia contributes less than half of the average for the 38 OECD member nations. The difference cannot just be sheeted home to the growth of Australia's very large resources industries: Australia's manufacturing decline has not been just relative to other sectors. Other OECD countries have seen relative declines in their manufacturing shares of total employment and GDP, mainly to services. But in Australia larger relative declines have equated to large absolute declines in manufacturing employment and, over the past decade, in actual output. The automotive sector was the highest profile – but far from the only - casualty of this broad trend.

### Manufacturing employment in Australia



Our low manufacturing self-sufficiency and undersized manufacturing sector mean we run a large annual trade deficit (just under \$190 billion) centred particularly on knowledge-intensive elaborately-transformed manufactures. We export largely unprocessed raw materials to buy other countries' sophisticated products, which often use the minerals we have exported to them.

## Manufacturing contribution to Australian economy



The disruption to global supply chains from the Covid-19 pandemic brought to the surface longer-term underlying anxieties amongst Australians about the loss of basic industrial capabilities, which has compromised the nation's security and capacity for sovereign action and decision-making. More generally, the pandemic has exposed that today's Australian economy:

- Lacks essential industrial capabilities associated with advanced economies
- Has pronounced reliance on fewer, lower value-adding, and mostly extractive industries
- Is especially vulnerable to external shocks, including growing actions by our trading partners to reduce carbon pollution and climate change, and
- Is narrowly based, exposed, and lacks the diverse portfolio of economic activities required for resilience in the face of significant changes.

Manufacturing should be front and centre of any attempt to find new sources of growth for Australia, because of its high returns to our economy and society: as the most knowledge-intensive sector, it drives innovation and productivity growth, invests heavily in R&D, and has strong linkages to other sectors like agriculture, resources, and high-end services. Manufacturing is critical for innovation across the economy, as it is also for capturing complementary and interdependent high-end services, with so many of the former divisions between them becoming blurred.

Other nations recognise this and have ambitious and comprehensive industrial policies and strategies to defend and extend their manufacturing shares. Not just companies but also nations and regions compete globally, through a range of policies, strategies, and programs, to localise the benefits of specific industries. Innovation is not something individual firms do all by themselves but depends on intense collaboration across businesses and institutions and on having clear national goals and targets.

The puzzle is that whilst Australia starts from well behind other advanced nations, needing to reverse the effects of 25 years of deindustrialisation, our policies are less ambitious than those of nations that are well ahead of us. Australia has no national industrial policy competitive with the comprehensive policies of other advanced nations. There is nothing in place that comes near the nature and scope demanded by our position as a deindustrialised country.

Australia needs a national industrial strategy to help catch up to other nations we have fallen so far behind, and to achieve much greater levels of self-sufficiency and effective sovereignty for resilience in the face of future external shocks. Australia needs an industrial policy to add value to and make the most of its immense natural wealth, which we currently sell in abundance to the world in low value unprocessed form. A national strategy will help Australia build new knowledge-intensive complex industries and businesses and promote the widespread adoption of digital technologies and Industry 4.0. It will also use existing (but now often isolated and subscale) areas of excellence to help us build manufacturing capabilities at scale with economy-wide impacts and benefits. A national industrial strategy is central to Australia's achieving the immense economic benefits of an orderly transition to a carbon-free economy, and to becoming the renewable energy superpower it should be. A national strategy for reindustrialisation would boost critical society-wide goals such as decarbonisation, full employment, the circular economy, and making sure that economic growth is inclusive of all Australians. But Australia's reindustrialisation cannot start before we accept the need for a national plan supported by the Commonwealth and state governments, industry and unions, and backed by an expert and accountable public authority, with explicit goals, targets and timelines.

## 2.1 Reindustrialisation in Australia

Australia's potential for reindustrialisation and revived manufacturing is favoured by large-scale trends, that need to inform the development of new strategies:

- The great but neglected potential for Australia to add value to its immense endowments of both traditional and new high-growth minerals and ores through secondary processing prior to export and associated targeted product manufacture
- The need for decarbonisation linked to Australia's vast supplies of renewable energy and metals and materials demanded by the low emissions future economy, together with the requirement for production and processing close to the renewable power source
  - Energy intensive processes such as steel and aluminium production are affected by transport costs for the energy source. For carbon-based processes it is cost effective to ship bulk coal for offshore processing and production. Carbon free energy is expensive to export, favouring onshore Australian production and value-adding for subsequent export
- The rise of digital technologies and new business models that allow competitive flexible short- to medium-run production
  - Australia will today struggle to compete in certain economy of scale-dependent industries requiring declining unit costs over long production runs. Industry 4.0 has however opened opportunities for production of high-value, high-complexity goods, often using advanced materials (from raw minerals Australia has in abundance), and enhanced by strong service-based offerings
- The increased awareness of global value chain vulnerability and recognition that certain basic capabilities need to be held and maintained onshore as sovereign capabilities.

Australia has many resources of high global importance. But we overwhelmingly export our resources as basic raw materials for value-adding and processing offshore. Almost half of the

world's supply of iron ore was exported from Australia in 2019<sup>2</sup>. But Australia accounted for less than half of one per cent of world iron and steel production. Overall, Australia exports almost 30 per cent of the value of unprocessed ores traded globally. But again, our share of exports in metals is less than one per cent.

Australia has world-significant resources for renewable energy production (solar and wind principally), as well as the mineral resources demanded by the net zero-carbon economy of the future: iron ore and bauxite into green steel and aluminium; together with other minerals including lithium, copper, nickel, zinc, graphene, titanium, cobalt, vanadium and others. But onshore value-adding and processing is very limited. Australia misses the benefits from onshore production and value-adding to its world significant resources.

Value-adding and processing has received almost no attention from successive governments over the past 25 years, during which we have regressed to become largely an exporter of unprocessed ores. This means that:

- First, we have lost production capacity in traditional metals such as steel and aluminium
- Second, we have failed to develop production capabilities for the new and advanced materials in great demand for the coming zero-carbon economy, despite having world-significant deposits of the raw materials.

Australia has the third-largest known resources of unprocessed lithium in the world, a precursor to lithium carbonate, an essential component of lithium-ion batteries, which have revolutionised low carbon generation. Australia has nine out of the 10 essential minerals required to make most types of lithium-ion batteries. But these are exported from Australia largely in unprocessed low value form, for other countries to perform value adding and manufacture. Secondary processing of lithium is essential for Australia to become a battery cell manufacturer.

Australia captures less than one percent of the potential value of the lithium battery value chain for its economy<sup>3</sup>. Australia overwhelmingly exports these critical components in their unprocessed form for offshore electro-chemical processing, cell production and product assembly. One tonne of our unprocessed lithium sells for around US\$750, compared to the US\$150,000 price of batteries using one tonne of unprocessed lithium<sup>4</sup>.

Yet lithium and battery storage change everything for the better when it comes to renewable energy, and Australia as a renewable energy superpower. And, more generally, it is the processing of our world-class raw materials that provides a major key to Australia's reindustrialisation.

Decarbonisation of the world economy must commence immediately to prevent catastrophic global warming. This does not mean the end of economic growth, as opponents claim. It means cutting the economy's dependence on carbon. Australia's brightest opportunities are in the rapid transition to a net zero-carbon economy. The growth will come from massive investment in fossil-free energy and technologies, and deliberate focus on the development of new industries, products, and services, and on new ways of producing them.

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<sup>2</sup> The Growth Lab at Harvard University (2019)

<sup>3</sup> Australian Trade and Investment Commission (2018)

<sup>4</sup> Australian Trade and Investment Commission (2018)

Although Australia is one of the world's highest per capita carbon emitters<sup>5</sup>, we can start the transition soon to net zero without cost to our economy. Australia has one of the highest per person endowments of renewables in the world, with excellent capacity for power generation from the sun and wind. The dramatic fall in the cost of solar and wind power, the fall in cost of investment capital and the rapid development of battery storage technology now makes coal the most expensive energy source.

Australia can become an exporter of low emissions energy to the world and use this to become a processor of its own raw materials once again. These will now be low carbon products from steel and aluminium through to silicon, lithium-ion, titanium, nickel, cobalt, zinc, graphene, vanadium – all needed for the products demanded by the future low carbon economy.

### LOW CARBON MANUFACTURING

Carbon intensive energy sources like coal can be exported at low cost. This has in the past incentivised energy-intensive manufacturing like steel and aluminium to happen offshore.

But, as energy generation becomes less carbon intensive, the value proposition for onshore processing of minerals increases, because of the higher transportation costs of renewable energy.

A positive cycle can be created where renewable energy sources are used to manufacture products and equipment, that can then be used to build increased renewable capacity.

Some examples include wind turbines using green steel and aluminium, solar panels using emissions-free silicon, and lithium processing leading to the development of an Australian lithium-ion battery industry.

### AUSTRALIA AND BATTERY TECHNOLOGY: VIEW FROM THE US

Despite significant natural resource endowments of battery-related materials, Australia has not yet developed a broader ecosystem for advanced batteries. Australian state governments have introduced incentives to support the development of local battery industries, but the Australian Government has not yet developed a comprehensive national strategy to develop a domestic battery industry.

Australia has an abundance of key commodities needed to produce advanced batteries, such as lithium, nickel, vanadium, graphite, manganese, and alumina. These commodities require processing, however, before becoming battery materials. Australia currently has no Class 1 chemicals or battery precursors. Australia has no cell manufacturing, but it does have an active battery pack assembly industry. Australia only recycles two percent of its lithium-ion batteries, and its recycling processes typically disassemble and homogenize materials for export to places like Korea, which have developed battery recycling capabilities.

Australia currently lacks battery-specific initiatives at the national level.

**Building Resilient Supply Chains, Revitalising American Manufacturing, and Fostering Broad-Based Growth, 100-Day Reviews under Executive Order 14017, June 2021, A Report by The White House**

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<sup>5</sup> Ritchie and Roser (2017)

### 3 Building our knowledge industries and complexity

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Australia must strive for an industrial base that exhibits greater economic complexity. Economic complexity is built on the philosophy that what a country makes is what it knows. Complexity is a synonym for the knowledge intensity of a national or regional economy. It is not just about technology. The complexity of an economy is measured by the complexity of the products it makes. An economy that is over-reliant on unprocessed raw materials is far less complex than one which makes medical products, sophisticated chemicals, and machinery. Complexity is centred on manufacturing capabilities.

Economic complexity is important because it is a predictor not only of current economic growth, but also the pace and direction of future economic growth. Countries that have higher GDP than predicted by their level of complexity are expected to grow slower in the future. Australia is one such country. We built our prosperity on industrialisation, but deindustrialisation means the continued decline of complexity. Australia's current level of economic complexity ranks it 86<sup>th</sup> of 133 countries, below the oil dependent countries of Qatar and UAE, and a decline of 31 places since 1995.

Complexity needs to be a component of a national reindustrialisation strategy. Building complexity means building knowledge intensive industries, which in a virtuous cycle, helps build more knowledge intensive industries. But in countries with low complexity like Australia it is more difficult to diversify the industrial base, and increase complexity, as there are fewer knowledge intensive industries which can create new products. This reinforces low complexity and means that active interventionist policies are required.

Economic complexity can help us to identify opportunities for new product development in an economy. But in Australia's case, this identification must pay greater attention to existing production capabilities, and link product opportunities to industry sectors and sub-sectors, while also casting a wide net for new industry openings including among large scale existing non-export opportunities which are not captured by standard complexity.

Part of building our knowledge intensive industries includes strengthening research and industry collaborations, deepening adoption of industry 4.0, and fostering cooperation between industry and intermediate bodies.

**Economic complexity** can be likened to a game of scrabble. Having more letters (capabilities), and letters worth more points (complex capabilities) allows for the creation of longer words (products) worth more points.

## 4 What is industrial policy?

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Yesterday's certainties become today's problems. Once few questioned that no or minimal government intervention would ultimately deliver the best outcomes for everyone, that policies targeting the development of sectors were self-defeating and bred inefficiency, that a nation's industrial structure should be decided by markets and 'comparative advantage'. But today, across advanced nations, industrial policy and strategy are back.

In truth, they never left. But in response to first the GFC and now the Covid-19 pandemic, governments, nations and citizens are recasting their approaches and embracing much more expansive, active and ambitious ideas of what industrial policies can do and should be called upon to do.

Increasingly, active and deliberately directions-setting industrial policies and interventions are gaining traction, with recognition of the centrality of manufacturing to providing new sources of sustainable jobs and growth, delivering essential sovereign capabilities, and for finding solutions to large scale challenges such as climate change, population ageing and growing social and economic inequality.

Historically, industrial policy has had many different objectives, but is most of all about helping steer a nation or region's industrial structure – the economic activities that make it up – in desired directions. This directional approach is the opposite of standard and static comparative advantage ideas. Industrial policy aims at capturing sectors and activities that provide higher returns to society than comparative advantage policies. This means targeting activities and sectors that embody greater knowledge intensity and have high beneficial spillovers and integrating industrial policies into broader missions to deal with largescale societal challenges, such as accelerated decarbonisation and capturing its economic benefits, ensuring the nation has sovereign capabilities, and making sure that growth is inclusive.

Sophisticated industrial policy is much more than generalised business support focussed on market failures and impediments. It prioritises key sectors and is comprehensive. It starts with identification and confirmation of an opportunity, through to finding the best pathways to hit defined targets and goals, through to designing and then applying the right strategies, interventions, policies and programs. It makes sure the line of approach is supported by those who must make it happen - industry, trade unions, government agencies, universities and research bodies and translation intermediaries. It does not involve restricting trade through tariffs but, promotes broad-based innovation through use of new policy levers like advanced public procurement and networks of flexible research and development and innovation bodies, and so on. And this industrial strategy helps address huge challenges of the epoch like decarbonisation and growing inequality.

### **INDUSTRIAL POLICY IN EAST ASIA**

In Japan, Taiwan and South Korea, industrial policy was used for industrial catch-up, and generating long-term improvements in living standards. Government intervention remains pervasive in developing strategic advantage. Public policies promoted progression upwards along the value chain and desired sectoral compositions, in line with a long-term strategic vision. Authoritative and expert public bodies have been critical in devising and implementing programs and strategies.

The critical instruments of positive structural change have been the public subsidy, and imposing discipline on industry. The active subsidy requires performance against measures such as investment, exports, productivity improvement and new product development.

Conditions are placed on foreign investors to ensure maximum contribution to local supply chain and capability development.

### **INDUSTRIAL POLICY IN THE UNITED STATES**

In the US, public procurement is used to generate largescale innovation. Starting in defence, this has since extended to energy, communications, health, and dual use technologies. Demand-pull forces are used to create new technologies, processes, and products, or adapting existing ones.

These processes occur through longstanding programs and institutions such as the Small Business Innovation Research (SBIR) program, and the Defense Advanced Research Projects Agency (DARPA).

Recently, the Biden Executive Order on 100-Day Supply Chain Review and Sectoral Supply Chain Assessments ordered comprehensive top-down review of supply chain resilience, capability and stability, risks and opportunities in identified key sectors (semiconductors, battery technology, defense, biological preparedness, food security, etc.). The Order contemplates reshoring of outsourced supply chains, building workforce capabilities, issues in access to finance and research and development, greater state intervention to shape markets and strengthen supply chains, and support for SMEs.

### **INDUSTRIAL POLICY IN THE EUROPEAN UNION**

In the EU, industrial policy is linked to system-wide challenges such as decarbonisation and greening the economy, as well as inequality and models for inclusive growth. Active largescale public procurement is used to stimulate local industry development and innovation, with an emphasis on sectors with potential to yield technological advantage and spill overs.

The European Commission's Smart Specialisation Platform helps stakeholders to define their competitive advantages and frame directions for future development. 'Entrepreneurial Discovery' helps coordinate information about new opportunities by bringing business, unions, academia, and various levels of government together in structured forums.

The development and diffusion of high-performance production systems is prioritised, and in Germany, Industry 4.0 is the official national technology policy. Their network of around 70 Fraunhofer institutes deliver Industry 4.0 high-end technology and businesses extension services.

Factories of the future and translational intermediaries help to bridge the gap between the technology and its application. There is often a focus on technologies for sustainable manufacturing.

### **INDUSTRIAL POLICY IN THE UNITED KINGDOM**

In the UK, industrial strategy is underpinned by Grand Challenges relating to AI and the digital economy, clean growth, the ageing society, and future mobility.

A strong emphasis is placed on Industry 4.0 promoted through nine Catapult Technology and Innovation Centres, each with specific sectoral or technology focus. The Centres aim to close the gap between 'concept and commercialisation'.

## 5 What Australia needs now

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Analysing and learning from Australia's historical experiences and current position, together with those of other nations, we can see in broad outline the main elements of the national agenda we need for reindustrialisation.

That agenda must be determined by Australian realities, but also take on lessons from other nations that are far ahead of us. It is not about unquestioning imitation but of careful analysis and adaptation to Australian conditions, needs and circumstances of ideas and initiatives that have succeeded elsewhere.

We must be smart enough to learn from others without naively copying them. And in supporting our own homegrown approaches.

The first step in this process is clear official recognition of the problem. Australia cannot meet the challenge by a few tweaks, here and there, to existing national programs and policies. The simple reality is that Australia has no national industrial policy or strategy. Progress starts with explicit recognition that we now have to rethink past decisions that unwound national industrial policy – and rethink them from top to bottom.

### 5.1 Develop a National Industrial Strategy under the leadership of a National Industrial Strategy Commission

The central condition for Australian reindustrialisation is the explicit official long-term commitment to a National Industrial Strategy (NIS), devised, supported and applied by an authoritative and expert institution, a National Industrial Strategy Commission (NISC), in turn involving the active support of the major stakeholders.

Today's Australian programs and policies are piecemeal and disjointed. They are not connected to any clear national objectives or mission. They are generic, oriented to more broad business climate issues, and perceived areas of 'market failure' or 'imperfection'. They are not part of a defined national strategy. They have a valuable focus on support for SMEs, more research and development, training and so on, but do not target key sectors and do not specify targets or timelines. The exception is the largescale defence procurement program. The recent Manufacturing Modernisation Initiative is modest in scale and, while it nominates some priority areas, it follows the generic approach. These are business support programs rather than industrial strategies.

The comprehensive national strategy we need is a complete cycle which starts with

- formal identification of existing and future opportunities, then
- confirming the opportunities and target sectors, by
  - analysing current and future strengths and weaknesses
  - understanding competitors and suppliers
  - looking at anticipated international market conditions and industry demand characteristics
  - understanding minimum efficient scale issues and barriers to entry
  - assessing the size and economic significance of the opportunity
  - defining decisive points along the value chain Australia needs to control to gain a strong foothold, then

- Defining the pathways for development (from where we are to where we want to be), then
- Designing the specific strategies, interventions, and policies and programs, then
- Putting these into practice in an industry or sector strategy and roadmap, with defined targets and timelines, and with the active support of key stakeholders.

This approach involves dedicated sectoral policies, which the current framework does not, with roadmaps and targets and timelines. Identification of the opportunities and challenges starts by building a practical vision and picture of the current and desired future structure of our economy by:

- Asking where do we want to be, given current strengths and weaknesses, and what can we realistically but ambitiously strive for?
- What are the emerging technologies and business models, and their relevance to our existing industries and what we want for the future?
- What are our current capabilities, and the areas of potential competitive advantage for Australia, together with gaps and opportunities in global and domestic supply chains?

These processes would be led by the Commission and are very like the European Commission's 'Smart Specialisation Platform' and its 'Entrepreneurial Discovery' processes, which bring together business, unions, academia, various levels of government and others, to gather, consolidate and systematise information about potential new industrial activities and opportunities. They are also like the Biden Executive Order on supply chains, which is a top-down review of supply chain resilience, capability and stability in target industries for independent sovereign capability.

Such processes assess, pinpoint, confirm and rank in order of benefit all the opportunities. Once assessed and confirmed, these would be translated into dedicated sectoral strategies and roadmaps with tailored national programs and time-based targets. Certain state programs and aspects of Foreign Direct Investment (FDI) policy would be dovetailed into these national sectoral policies and programs. Over time it would be very desirable to improve and simplify linkages and pathways between state and Commonwealth programs that are themselves often fragmented and subscale, calling for eventual reform and redesign.

**RECOMMENDATION:** Declare a policy for a National Industrial Strategy with development to be led by a National Industrial Strategy Commission, and with a process inclusive of all stakeholders: industry, trade unions, government and the education sector.

**RECOMMENDATION:** The Commission to commence opportunity identification in secondary minerals processing, low carbon transition and selected complexity-based targets (see below).

## 5.2 Develop Advanced Procurement as Industrial Policy Focussed on Target Sectors

Australia has vastly underplayed the potential of largescale public purchasing power to spur innovation and create new products and industries. Whilst advanced procurement as industrial policy is deployed in advanced economies across Europe, the United States and elsewhere, in Australia using procurement by public authorities to maximise longer-term public benefit attracts the same lazy formulaic objections levelled at industrial policy in general: that it is synonymous with subsidization or protectionism, that it offends principles of competitive tendering, and is more typical of developing countries with their lack of transparency, than the 'open' advanced economies. None of this is factual.

The US and Europe make explicit use of public procurement to stimulate local industrial activity and innovation. They do this typically with an emphasis on sectors with potential to yield technological advantage and spill overs, and that are vital to effective national sovereignty, and the avoidance of excessive external reliance: communications technology, electronics and software, aerospace, medical technologies, and especially defence. The policies involve using the massive purchasing power of states to create and capture national economies of scale, as well as to use that purchasing power as a demanding lead customer, able to drive technical improvement along the value chain.

Whole of life costs are privileged over direct capital costs in making procurement decisions. This tends to favour local activity, as well as local innovation, as it takes account of cheaper maintenance and modification close to source. These are strongly demand-pull policies aimed at bringing new products, processes and technologies into existence, moving the nation closer to the relevant technological frontier. This is distinct from general government contracting involving buying standard goods and services from off-the-shelf.

Only in defence industry does the Australian national government apply principles of this kind, on sovereign capability grounds. Elsewhere, the national government operates an Australian Industry Participation Plan framework, with state government policies complementing, and sometimes supplementing, its basic approach. This sets a requirement for an Australian Industry Participation Plan for public sector projects of \$20 million or above, or private sector projects of \$500 million or greater. Definitions are frequently imprecise, allowing slippage and potential for avoidance. 'Industry participation' is defined dollar terms as percentages of total contract value. No minimum levels of local content are mandated.

Beyond this, however, the weak quantitative (dollar value) local content frameworks do not consider qualitative issues explicitly addressed in advanced procurement practices in Europe and the US: what are the critical technologies and components of the value chain that must be captured to gain long-lasting economy-wide benefits and greater sovereignty? In other words, the local content framework is untargeted and disconnected from sectoral strategy and priorities.

Australia should develop a national strategic framework for advanced procurement in major public and private sector projects and priority sectors. The framework should have the following features:

- Targeted at sectoral priorities determined by NISC and indicated below
- Focussed on value capture and development of onshore production and associated capabilities and value chain development

- Ensure a focus pinpointed focus on critical points along the whole value chain to maximise returns
- Involve active negotiation with MNCs, primes and lead customers to ensure local content and industry participation in major projects and public procurement
- Look to opportunities to build scale and opportunities across concurrent projects with significant crossovers such as shipbuilding and offshore energy developments
- Use, and monitor performance against, explicit quantitative and qualitative targets
- Dovetailing by the states of their industry participation frameworks to the national framework.

**RECOMMENDATION:** The NIS to include a prominent role for active advanced public procurement as an arm of industrial policy. The new framework would focus on the priority sectors indicated below and, in addition to local content measured in dollars, would target onshore production and development of those value chain capabilities most important for future capability development, national sovereignty, and so on.

### 5.3 Promote Industry 4.0 Applications Through a National Network of Translational Intermediary Organisations/Bodies?

Australia's position underlines the point that there is no necessary relationship between the amount of research happening and the level of innovation in an economy. Instead, what makes the difference is having a highly networked economy, with effective translation of research to industrial development through intermediary institutions and organisations. Australia's research and development metrics have deteriorated recently (see below) but our principal weakness is in the translation of research to new products, processes, technologies and business models.

Collaboration is key, accelerating learning and absorption of new ideas, and sharing risks and rewards through common projects. Collaboration must be structured and purposeful, seeing firms work with their suppliers and customers as well as with research organisations (including universities) and critically, the growing number of intermediary bodies such as 'test-labs'.

Australia has institutions such as the CSIRO and several 'test labs' or 'future factories' affiliated to universities concerned to promote and demonstrate new digital technologies. These could be better networked and harnessed to a national strategy for accelerated adoption of Industry 4.0. Currently they operate in relative isolation from each other and without guidance from a national strategy.

With a more robust agenda these intermediate organisations should work at multiple levels - the individual enterprise, the industry cluster, sector, and the value chain – to diffuse and embed digital technologies. They should act strongly as industry multipliers and educators focusing on diffusion of Key Enabling Technologies and digital technologies and associated new business models. They would also focus on building value chain relationships and improving connections.

They could become one stop shops providing expert advice on specialist equipment and process reengineering, helping in new product development, product testing, technology demonstration, promoting industry clustering, and addressing the various impediments to digital adoption and adaptation relating to information, awareness, uncertainty, and risk. These impediments are particularly significant for small and medium-sized enterprises (SMEs).

Australia has the problem that available business support is first, usually generic lacking expert focus on the above issues and second, that programs are fragmented between Commonwealth and states and are often too small to have the impact required. Better integration could be achieved by networking the intermediary organisations and giving them more prominence as one-stop-shops and entry-points for a range of Commonwealth and relevant state programs.

On a distributed model they could become deliverers of advanced business services in partnership with relevant Commonwealth and state agencies, close and responsive to conditions in each state and region whilst developing their specific technological and sectoral expertise and specialisations. As is clear, their obligations would go well beyond research, with the more intensive focus on 'development' - to include workforce training and development, supply chain leadership, new business models, and so on.

Germany's 70-plus Fraunhofer Institutes and the UK Catapult Technology and Innovation Centres Program exemplify these positive approaches. There are presently nine Catapult centres focussing on Cell and Gene Therapy, Compound Semiconductor Applications, Connected Places, Digital, Energy Systems, High Value Manufacturing, Medicines Discovery,

### AUSTRALIA IS UNCOMPETITIVE ON COLLABORATION AND TRANSLATION

Australia rates very poorly on translation and application of research into economic and commercial outcomes. Against international benchmarks, Australian industry:

- has low 'capacity for innovation'
- has low co-production of research with industry
- is poor in its 'state of cluster development'
- exhibits low 'value chain breadth'
- low investment in 'intangibles' – things like organisational innovation and human capital, R&D and investment in ICT, and devising new business models.

Intangibles are critical to enabling a firm or industry to compete on factors beyond costs and production efficiency, including such product features as quality, sustainability, durability, flexibility, and enhancement of the product through bundling with services. They are essential for the successful adoption and embedding of Industry 4.0 technologies and systems. Investments in intangibles are part of the high road.

**See sources cited in Roos, G. (2013). The innovation ecosystem. In CEDA, Australia Adjusting: Optimising National Prosperity, Nov 2013.**

Offshore Renewable Energy, Satellite Applications<sup>6</sup>. These facilities are distinguishable by their scale, focus on high value industry development and long-term capability and capacity building.

By linking high-end research with businesses large and small in the nine focus areas the centres aim to close the 'gap between concept and commercialisation', and gaps in the national innovation system itself. The innovation centres aim to:

- Enhance business access to leading-edge technology and expertise
- Reach into the research base for world-leading science and engineering
- Undertake collaborative applied research projects with business
- Undertake contract research for business
- Be strongly business-focussed with a highly professional delivery ethos
- Create a critical mass of activity between business and research institutions
- Provide skills development at all levels.

The Advanced Manufacturing Research Centre (AMRC), Sheffield, has become a world-leading institute and is now central to the High-Value Manufacturing Catapult, a network of seven manufacturing centres across the UK. The AMRC has attracted major investment from the private sector (Boeing, Rolls-Royce, BAE Systems and Airbus) and the public sector (UK government, University of Sheffield and European agencies), including the 2015 establishment of 'Factory 2050'. This is the UK's first fully reconfigurable factory, focused on collaborative research on flexible reconfigurable production of high-value components, using digital and other technologies. The AMRC workforce has grown to more than 650 FTEs, including around 500 researchers and engineers.

**RECOMMENDATION:** Establish a national network of High Value Manufacturing 'Catapult' facilities led by University's in collaboration with industry and assist them to become effective delivery arms of the National Industrial Strategy. They should be developed as one-stop-shops and gateways to associated services to industry. They should form a national network and provide maximum integration and aggregation of existing Commonwealth and state programs, whilst also individually focussing resources on development of their technological and sectoral strengths and specialisations.

#### 5.4 Build Collaborative Research and Development (R&D) and Innovation

Australia's R&D performance has deteriorated markedly. Our R&D intensity has fallen from over 2 per cent of GDP less than a decade ago, to 1.79 per cent today. We are consistently below the OECD average for gross expenditure on R&D (GERD) as a percentage of GDP (1.88% of GDP, compared to the OECD average of 2.38%). Business Expenditure on R&D (BERD) has also fallen. Further, the linkages of these R&D efforts to actual production and innovation (translation) have become weaker, as seen above. Research is much stronger than development and innovation.

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<sup>6</sup> Catapult Network (2020)

Research inputs are high relative to positive outputs – such things as ‘new-to-market’ innovations. We perform poorly in translating publicly funded research into commercial outcomes, and there is weak collaboration between the research and business sectors. The principal forms of public support for business R&D, particularly the R&D Tax Incentive, provide questionable additionality (that is, the extent to which the scheme funds additional R&D or effectively subsidises that R&D which would have occurred in any event).

On the positive side, this means there are opportunities for Australia to make more of its R&D spending. The broad agenda for change is quite clear. It is to link incentives for R&D to actual production and collaboration, rebalancing from pure grant funding or tax concessions to more public support for collaborations centred on defined missions and projects, with a focus on onshore product, process and technology development. The R&D Tax Incentive could be restructured to prioritise and reward onshore development of products and collaboration between businesses in a supply chain, and between businesses and research translation intermediaries. A component of this should be applied to onshore value adding to our minerals and green energy sources. The overall approach should be complemented by

a target, as part of the NIS, to increase and sustain a level of R&D intensity for the Australian economy that exceeds the OECD average over a determinate period.

### AUSTRALIA LAGS IN RESEARCH BUT EVEN MORE IN DEVELOPMENT AND INNOVATION

Weak frameworks for collaboration and poor incentive structures mean that the research we do is frequently disconnected from subsequent product or process development and innovation and full application. Recent international surveys find Australia rates poorly:

- in proportions of researchers working with industry
- in co-authored industry and research papers
- on new-to-world innovations.

Australia’s innovation input is stronger than output: we are well above the OECD median for inputs, and we could make more of our R&D spending.

We have actually declined in international rankings in:

- ‘innovative capability’ and ‘multi-stakeholder collaboration’
- collaboration for innovation, coming last (29<sup>th</sup>) in the OECD for SME collaboration with universities.

See Koutsogeorgopoulou, V., & Park, T. (2017). *Boosting R&D outcomes in Australia*; Schwab, K, World Economic Forum. (2019). *The Global Competitiveness Report 2019*; Office of the Chief Economist. (2017). *Australian Innovation System Report*.

**RECOMMENDATION:** Institute a dividend in public R&D support for onshore product, process and technology development, and for supply chain and research collaboration.

**RECOMMENDATION:** Set a timebound target for Australia to achieve greater than OECD average R&D intensity, as a component of the NIS.

## 5.5 Reindustrialisation: Building Complex Industries

The Strategy and Commission should identify the most significant and highest value opportunities for Australia to build complex, knowledge-intensive activities, sectors and subsectors. This poses challenges for a country like Australia which, due to deindustrialisation, has lost complexity dramatically. There are fewer opportunities as a result, and certain of the opportunities identified only using complexity will be subscale and of small significance for the national or regional economies. However, opportunities do exist.

One is the potential to leverage opportunities from major defence projects such as naval shipbuilding for diversification into near-by products, technologies and subsectors. Given the sophistication and complexity of naval shipbuilding, potential spill-over opportunities may be in: food and wine, aquaculture, medical technologies, assistive technologies, intelligent housing, autonomous vehicles and intelligent transport, robotics, energy systems and storage (including lithium batteries and wind turbines), simulation technologies, Key Enabling Technologies (such as photonics and nanotech), new materials and others.

A separate assessment identifies a portfolio of opportunities in the sectors of: agricultural machinery, mining and metals processing equipment, defence, medical devices, and environmental monitoring and energy technologies. These would be confirmed by the Commission to ensure their viability and sufficient impact for inclusion in the Strategy.

**RECOMMENDATION:** The NISC to oversee work on targeting high-value and high-impact opportunities for onshore development of complex, knowledge-intensive industries, clusters and value chains.

## 5.6 Reindustrialisation: Secondary Processing and Product Manufacture

Australia's world-significant endowments of natural, mineral and energy resources should be an active focus for the NIS. This would mean targeted value chain strategies, from raw materials processing through to selected product manufacture (including the above complexity target areas and the products associated with decarbonisation, below).

In undoing a century of industrialisation, Australia has over the past 25 years largely regressed to being an exporter of unprocessed raw materials for value adding offshore. Our world-significant deposits of high-value resources and energy sources apply to both the energy inputs required by decarbonisation of our economy and to new opportunities requiring new materials and products needed in a decarbonising world economy. The opportunities are vast.

But over the past quarter century Australia has lost much secondary processing capacity it once had in traditional ores. National policy has been to encourage export of unprocessed raw material and energy, instead of a national policy promoting processing and value adding onshore. Consequently, Australia's current position is one of having:

- lost processing capacity in traditional metals like steel and aluminium, and
- failed to develop production in new materials that are highly-prized in the future low carbon economy.

We hold these in abundance, but export them in unprocessed form: titanium, lithium, copper, nickel, cobalt, vanadium, silicon, ammonia and graphene, to name just some.

These resources and minerals should become the focus of dedicated sectoral strategies aimed firstly at onshore value-adding and then opening out onto specific proven product manufacture opportunities, linked especially to the urgent imperative of decarbonisation. This should include stronger terms for FDI linking to value adding and the goals and targets of the sectoral policies.

Contrary to popular myth, both the further development of our resources and energy sectors, and accelerated decarbonisation, are central to Australia's agenda for reindustrialisation.

**RECOMMENDATION:** The NISC to devise effective sectoral strategies for onshore processing and value adding to targeted raw materials and minerals.

## 5.7 Reindustrialisation: Decarbonisation

Onshore secondary processing of Australian raw materials is favoured by decarbonisation. Australia's vast supplies of renewable energy and materials and metals demanded by the low emissions future economy, together with the requirement for processing close to the (renewable) energy source add to the case for reindustrialisation. High transport costs for green energy mean energy-intensive production of things like aluminium and steel need to occur close to the source of power.

### **A VIRTUOUS CYCLE – FROM RENEWABLE RESOURCES TO GREEN AUSTRALIAN PRODUCTS AND BACK AGAIN**

Our very large endowments of both renewable energy and key minerals provide opportunities for a future virtuous cycle in which Australia uses its “renewable resources to manufacture products and equipment, that in turn can be used as inputs in the further development of that renewable endowment”, including:

- Green aluminium and green steel, with their specific application to production of wind turbines and solar panels
- Solar panel production using emissions-free Australian silicon
- Using renewable energy to power lithium processing and a lithium battery industry
- Using that lithium battery industry development, and the electrification of transport, to develop an electric vehicle and public transport equipment manufacturing industry
- Transmission technology for an upgraded electricity grid: towers, wires, transformers
- Ensuring planned expansions of housing stock result in reduced carbon footprint and greater energy efficiency
- Development of silicon for use in computers and PV panels
- Ammonia production powered by hydrogen.

See Stanford, Jim. A Fair Share for Australian Manufacturing: Manufacturing Renewal for the Post-Covid Economy. The Centre for Future Work: Australia Institute, 2020

Beyond Zero Emissions. The Million Jobs Plan: A Unique Opportunity to Demonstrate the Growth and Employment Potential of Investing in a Low-Carbon Economy. [https://bze.org.au/research\\_release/million-jobs-plan/](https://bze.org.au/research_release/million-jobs-plan/): Beyond Zero Emissions, 2020

Garnaut, Ross. Superpower: Australia's Low-Carbon Opportunity: La Trobe University Press, 2019

Wood, Tony, and Guy Dundas. Start with Steel: A Practical Plan to Support Carbon Workers and Cut Emissions. <https://grattan.edu.au/report/start-with-steel/>: Grattan Institute, 2020

Contrary to another myth, decarbonisation does not mean economic loss to Australia. We can in fact make a properly managed transition to net-zero emissions sooner and without losses. Because of Australia's huge endowment of cheap renewable energy, Australia can become a net exporter of green energy to the world. We would be richer sooner under zero-emissions policies.

We can also create a virtuous circle from secondary processing of our raw materials and decarbonisation that moves us progressively further up the value chain to make more of the sophisticated complex products we need. These would be key inclusions in the NIS.

Environmentally sustainable products and green manufacturing have great potential for advanced economies and innovation-based manufacturing. The ‘clean economy’ producing goods and

services of environmental benefit is estimated to be three-times more manufacturing-intensive than the economy as a whole.

The transition from fossil fuel energy intensive production of minerals and metals like steel and aluminium can be organised with minimum disruption to workers in these industries through renewable energy zones. This involves public underwriting of the provision of renewable energy at stable prices for production of energy intensive metals. These can become flagship projects for the adjustment of carbon-dependent regions such as Gladstone, the Hunter Valley, Latrobe Valley and Whyalla.

This could be a component of the idea of 'just transition' that should be applied to the workers, regions and industries most affected by closure of carbon intensive activities in the move to renewable energy and new zero emissions industries. 'Just transition' is most often associated with policies adopted in Germany first to the closure of coal mines and later to its phase out of nuclear power. However, concrete applications of 'just transition' principles are found in many nations.

It involves partnerships of government, industries, workers and regions setting directions for positive change and planning the transitions they need to make. Where an industry needs to be phased out, the timeframe is used to create positive alternatives for the affected workers and communities. These include decent notice and transition periods for workers alongside maximum opportunities for retention, redeployment and retraining through labour market programs.

It involves plans and strategies for orderly transition to maximise benefits from replacement industries for affected regions, often helping to retain existing skills and infrastructure by targeting development of new industries and supply chains with complementarities to the old ones. Making the most of existing skills and regional infrastructure not only ensures a fairer transition; it also delivers an efficient and less costly transition.

**RECOMMENDATION:** The NISC to devise industry strategies and roadmaps to ensure Australia maximises the economic benefits of decarbonisation.

**RECOMMENDATION:** The industrial strategy for decarbonisation to include 'just transition' measures to ensure that current carbon-dependent workers and regions benefit from the new industries that will come from planned and orderly transition.

## 5.8 Catching Up: Opportunities from the Circular Economy

Australia today not only fails to add sufficient value to its immense high-value natural resources: it is also well behind other advanced nations in its capacity to recycle highly valuable materials and products at the end of their specific product life. These are resources with many successive lives provided a system exists to support such a virtuous cycle. To take just two examples, Australia lacks the ability to recycle titanium- or lithium-ion-based products at the end of initial product life. Instead, Australia exports unprocessed minerals, imports them as sophisticated high-value products (e.g., titanium-based medical devices), and must send them offshore for recycling at the end of their life as a single product. Or they are wasted altogether by remaining unrecycled.

Australia's broader domestic waste policy is informed by sound principles (including banning the former practice of wholesale export of waste to China) but is fraught by slow progress in growing domestic capacity. Yet this too is a major economic opportunity, including turning waste dumps into mines for the recycling of metals through new digital and robotic technology.

The focus on secondary processing of our raw materials and on decarbonisation as major openings for manufacturing needs to be complemented with one on the circular economy. Australia's economy is extractive and linear: multi-use materials are not recycled within the nation but appear as yet another import if they are recycled at all.

Circular economy concepts seek a closed loop system not only to minimise waste and enhance sustainability, but also to keep resources in productive use for longer to enhance productivity. The focus is on reuse, repair, refurbishment, remanufacturing and recycling to create integrated production. It has three essential principles: to reduce or eliminate waste and pollution in production and use of the product; keep the product or materials in use for as long as possible; and regenerate natural systems. It takes responsibility for the full lifecycle of the resources. It implies a degree of self-sufficiency, effective sovereignty and onshore lifecycle processes well beyond Australia's present position. But moving in this direction is favoured by our resource and green energy endowments, the more robust industrial policies advocated here, and applications of Industry 4.0.

The circular economy is relevant to everything we do: resources and energy, agriculture and food production, manufacturing, transport, construction and urban development, and information technology. The CSIRO has several discrete circular economy initiatives. The issue is which areas to target initially for maximum impact, as a scatter gun approach will be ineffective.

**RECOMMENDATION:** At an appropriate juncture, the NISC to take on scoping and design of a nationwide circular economy strategy.

## 5.9 Powering Manufacturing Investment

Between 2003 and around 2013 Australia experienced a one in one-hundred-year resources boom, centred on iron ore, coal and offshore gas extraction. The dimensions of this resource industry growth can be grasped when it is appreciated that we usually call something a resources boom when it either results in a significant boost to Australia's terms of trade or significant rise in resources investment: our 2000s boom had both.

The boom was largely unregulated. Its costs included a dramatic rise in the exchange rate and internal costs that rendered many value-adding industries uncompetitive, leaving Australia with today's industry structure of a smaller value-adding sector and a pronounced dependence on low value resource extraction.

The benefits of the boom were a temporary boost to national income and expenditure. The way to ensure long term benefit from such a dramatic one-off boost to income is to establish institutions to save and accumulate a proportion of it for future investment, such as sovereign wealth funds. Instead, Australia used the temporary proceeds for consumption, including tax cuts.

Other countries, including the famous example of Norway, used their temporary good fortune for long-term benefit. Norway not only used its North Sea oil to create one of the largest savings pools in the world, but also to develop high-end manufacturing companies today still supplying technology to the globe, long after North Sea oil was exhausted. Similarly, Denmark's retirement and savings funds align to the nation's industrial policy, investing in industries and institutions that support green transition. There it is accepted that whilst such funds must invest to ensure members' returns and income, a part of the capital accumulated overwhelmingly from wage-earners' savings can and should be reinvested productively into the real economy to support employment and wage-earners' living standards into the future.

Although Australia's time for a Norwegian-like sovereign fund may have passed with the mining boom, Australian superannuation funds hold around three trillion dollars of savings, owing to sustained favorable public policies. Similar funds the world over are being asked to divest from fossil fuels and to actively support the development of green technologies. Australian superannuation funds should be asked to support the NIS by earmarking a very small proportion of their large portfolio of funds for onshore manufacturing projects with a focus on green technology and secondary processing of material required by the zero-carbon economy, and greater national sovereignty. A very small proportion of the huge funds of superannuation bodies would make an enormous difference to Australian manufacturing.

**RECOMMENDATION:** Negotiations should proceed, as part of the NIS processes, to seek agreement with the Australian superannuation industry to dedicate, over time, a very small proportion of its vast reserves to onshore manufacturing development, particularly linked to low carbon technologies, adding value to our natural resources and greater national self-determination.

## 5.10 Investing in Ourselves: Workforce Development and Strategy

In like manner to Australia's break from national industrial policy, we have by degrees arrived at a deeply inadequate and dysfunctional system of workforce training and development. This judgement applies to the whole framework for skills acquisition and development across the nation but its deficiencies are especially pronounced in manufacturing.

Even orthodox economists and policy makers accept that skills training and workforce development are especially prone to 'market failure' problems of underinvestment and 'free riders' (businesses incentivized to poach trained workers from other firms rather than invest in training themselves, adding to the problem of underinvestment overall). Standard textbook economics says that such a situation requires public authorities to play a key role, set rules and standards, and actively train and educate directly. Yet over the past two decades governments' policies have amplified these market failures. They aggressively reduced funding to public providers of workforce skills and training, required 'contestability' (expanding opportunities for private providers of dubious quality and capability to bid and often win significant work packages), and implemented outsourcing and often, outright privatisation.

Expanding the market to private provision in this way required lowering the barriers to their entry. Quality and relevance suffered. Australia is left with a fragmented patchwork of providers and inconsistent standards, incapable of responding to the large-scale challenges facing us. Australia's training system seeks supply-demand balance of skills at the micro level, including through micro courses that plug immediate holes but do not provide the breadth of education required by modern digital technologies, agile enterprises and interdependent value chains.

Significantly also, micro-qualifications are likely to be of low value to the worker, as they will not represent skills transferrable to many other enterprises.

This contrasts sharply with Scandinavia and nations such as Germany, that have built industrial economies on training and workforce development as a supply-side investment, not simply a cost always to be minimized. Today's industrial scene applying digital technologies for flexible and agile production of a diverse array of sophisticated products needs workers with high quality skills and training providing the base for flexibility and additional skills as production, markets and industries evolve. In such an environment the idea of finely and cheaply calibrating skills supply to immediate minute requirements alone is a fiction.

Germany and Scandinavia tell us that a future-oriented supply-side system needs to plan around the broad trajectories and trends of future demand, industries and technologies. This arms for the dynamic future and helps plug immediate holes better than a system of patchwork ad hoc responses. This is truer today than ever before as Industry 4.0 has made the target for success a continuously moving one, reordering and changing production norms and opening up opportunities for new products and associated services.

Even without reindustrialisation, Australian manufacturing faces workforce demographic challenges, with a large proportion of the workforce close to retirement. Just to stand still by replacing those leaving is a big issue. But reindustrialisation makes workforce development an even bigger issue, not just quantitatively but also qualitatively. Industry 4.0 increases the skill-intensity of production, asks more of workers, requires new specialisations, and demands flexibility. Under the NIS, digital technologies and automation should not spell fewer workers but a greater diversity of different jobs. Without a national strategy accelerating the

development of new products and markets, however, automation will be more about removing layers of the workforce without creating the new jobs to take their place.

In the above-mentioned European nations, workforce development is guided by foresighted and long-term institutionalised and cooperative planning, involving deep collaboration between government, industry, unions and training institutions. Australia needs to change course on manufacturing skills and workforce development by embracing a national strategy.

**RECOMMENDATION:** Parallel to, and in close connection with, the processes of the NIS and NISC, a national plan and strategy for manufacturing workforce development should be initiated and include a Commission of industry, unions, government and training providers to develop the strategy, set targets and goals, and direct the implementation of the plan. The plan should include cooperative partnership arrangements at designated industry cluster and regional levels, including stronger TAFE provision, and a focus on accelerated diffusion of key Industry 4.0 competences, and include TAFE and intermediary institutions.

**RECOMMENDATION:** The national vocational and education training system (VET) should be rebuilt with key reform elements including acceptance of the primacy of public provision to ensure overall performance and accountability, and reinvestment into the system, linked to clear goals and targets.

## 6 Further Reading

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This paper draws on many valuable sources. To assist accessibility and readability, references and citations are kept to minimum in the text. However, the following are the principal sources of information and evidence used in this document and are recommended for further reading.

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Australian Industrial Transformation Institute  
College of Business, Government and Law  
Flinders University  
GPO Box 2100  
Adelaide SA 5001  
**P:** 08 8201 5083  
**E:** [aiti@flinders.edu.au](mailto:aiti@flinders.edu.au)

