# *Manufacturing the Energy Revolution:*

## *Australia's Position in the Global Race for Sustainable Manufacturing*

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**and**

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**The Centre for Future Work at the Australia Institute**

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# Summary

Australia needs to respond quickly to powerful new incentives for sustainable manufacturing now on offer in the U.S. and several other industrial countries, or risk being cut out of lucrative new markets for manufactured products linked to renewable energy systems.

This report reviews the new incentives for production of batteries, electric vehicles, renewable energy generation and transmission equipment, and other renewable energy products provided under the Biden Administration's Inflation Reduction Act (IRA) and parallel public programs.

Many other industrial countries, including the EU, China, Japan, Korea, and Canada have also quickly implemented major new policies to respond to the impact of these U.S. measures, and support the expansion of production in those countries of manufactured products and technologies for renewable energy systems.

Australia is considering its response, but with no clear announced strategy yet.

The report provides evidence that the U.S. incentives and content requirements are sparking an unprecedented expansion in manufacturing investment in the U.S. The extraordinary economic response to these measures confirms they are having an outsized effect on the volume and location of sustainable manufacturing investment. It also confirms that Australia must move quickly to respond to this new industrial landscape, or risk losing its chance to leverage its abundant renewable energy resources into lasting, diversified industrial development.

Australia has many advantages in the global race for sustainable manufacturing: including an unmatched endowment of primary renewable energy sources, and ample deposits of critical minerals that are essential to production of renewable energy equipment. However, the painful legacy of decades of policy neglect for domestic manufacturing has left Australia's industrial base in poor shape to seize the opportunities being opened up by the global energy transition.

Without strong support for to quickly enhance domestic manufacturing production, skills, and technological capabilities, the main industrial outcome of the energy revolution for Australia may be simply replacing one set of unprocessed exports (coal, oil and gas) with another (raw lithium and related critical minerals). Most of the spin-off benefits of the renewable energy revolution for industry, technology, value-added and diversification will pass Australia by.

After an introduction to the theory and practice of industrial policy, and its connection to the renewable energy transition, the second section of the report provides a catalogue of new climate industrial policy measures in the U.S., China, and other major economies. The third section reviews measures taken so far in Australia to support both the expansion of renewable energy generation, and also to leverage that transition into demand for domestically-produced manufactured products. So far, Australia's response has been hesitant, incomplete, and fragmented – although the most recent Commonwealth budget announced a new internal task force to develop a more comprehensive response to the U.S. IRA.

The final section of the report estimates the proportional fiscal effort that would be required to match the American IRA in the Australian context. The government would need to commit $83 to $138 billion over 10 years in fiscal supports and incentives to match U.S. benchmarks for domestic renewable industry. This does not include the direct capital cost of renewable energy projects themselves.

That is a major fiscal commitment by any standards, but not out of reach for Australia. The common claim that Australia cannot afford to undertake measures that are proportionately equivalent to the IRA is not convincing. Enhancing Australia's capability to produce the manufactured products required by the renewable energy revolution, and to position other manufacturing to take advantage of growing supplies of clean energy (such as green steel and aluminium production), would pay off in stronger economic and employment growth, less vulnerability to volatility in global fossil fuel markets, and a stronger political constituency to support the renewable energy transition.

The report also recommends several qualitative best practices that should be incorporated into the Australian response to the IRA, to generate maximum economic, social and environmental impact: including strong labour and environmental standards attached to subsidized projects, public equity participation, and parallel investments in training for workers to fill the new jobs.

# Introduction

Many prominent voices – from economist Ross Garnaut to Prime Minister Albanese – have spoken about the prospect of developing Australia into a 'renewable energy superpower'. There is now a stronger willingness in Australia to embrace the opportunity of decarbonisation, utilising Australia's extensive natural resources and global economic position to make the most (both economically and environmentally) of the accelerating clean energy transformation. However, given massive government intervention to support renewable energy developments and related manufacturing in the United States, China, Europe, and beyond, the starting gun on the global sustainable manufacturing race has been fired – and Australia is barely on the track.

To address the accelerating global climate crisis,[1] all economic sectors must be rapidly decarbonised: especially agriculture, transport, housing, energy, and industry.[2] This demands a widespread, rapid, and coordinated economic transformation, encompassing energy systems, industrial techniques, transport infrastructure, and agricultural processes.

Energy generation is central to this transition. Energy usage accounts for nearly three-quarters of global greenhouse gas emissions, encompassing fossil-fuel-generated electricity, as well as petroleum, diesel, and gas usage.[3] Decarbonisation requires that sectors that have hitherto been powered by fossil fuels must in future be powered by renewable energy. This will require a significant expansion of electrification, particularly in transportation and industrial sectors, combined with a decarbonisation of electricity generation through a rapid shift to renewable energy supply. In total, this amounts to nothing less than a renewable energy revolution.

In turn, this revolution creates profound opportunities for states, communities, and sectors. Notable among those presented with historic opportunities as a result of the energy revolution is the manufacturing industry.

The energy transition has two main implications for manufacturing. Firstly, manufacturing itself is currently highly carbon intensive. In 2016, the manufacturing industry accounted for 29.4% of global emissions: 24.2% from energy use and 5.2% in direct industrial processes.[4] These processes themselves must be decarbonised,

[1] Slezak and Florance (2023).
[2] Krishnan et al. (2022).
[3] Ritchie, Roser and Rosado (2020).
[4] Ritchie, Roser and Rosado (2020).

necessitating significant changes to existing industrial techniques. Secondly, economy-wide decarbonisation requires a vast amount of specialized equipment and technology, such as renewable energy generation and transmission equipment, electric vehicles and batteries, and other machinery and equipment to replace carbon intensive technology. In Australia alone, nine-fold increases to wind and solar electricity generation capacity, and energy storage capacity increases by a factor of 30, are required by 2050 to meet net-zero demands.[5] Accordingly, manufacturing output to support these clean energy systems must be massively expanded.

These two imperatives create significant opportunities for the manufacturing industry. Manufacturing businesses can profit from innovative renewable and low-carbon manufacturing techniques, as well as by producing manufactured inputs for new clean energy developments. Through this, communities can be revitalised through a clean-technology-led reindustrialisation. Governments can also benefit from the economic flow-on effects of innovation, productivity, secure employment, and enhanced incomes and tax revenues that renewed manufacturing industries can support.

This report describes the opportunities facing Australian manufacturing from the global renewable energy revolution. The country is blessed with unmatched resources of both primary renewable energy (solar, wind, and other renewable energy forms), and enviable endowments of many of the critical minerals required for renewable energy technologies (such as lithium). This would seem to give Australia a head-start in the global race to develop the technologies and manufacturing capacities needed to prosper from the energy transition.

Unfortunately, Australia is also hobbled by structural disadvantages that – in the absence of powerful countervailing policy interventions – will constrain our share of the coming global renewable energy boom. Some of those disadvantages are beyond our control: including a small domestic market and geographic isolation. Others, however, are the self-inflicted legacy of decades of inappropriate economic policy: in particular, a willingness to accept an underdeveloped status in international supply chains, relegated largely to the extraction and export of non-renewable minerals, rather than endeavouring to construct a more diversified and robust industrial base. This legacy is most visible in the erosion of Australian manufacturing over the last two decades (which has now shrunk to a smaller share of national GDP than any other OED economy), and a corresponding expansion in the nation's reliance on primary exports in its international trade.

[5] AEMO (2022).

This structural weakness is being exposed vividly by the sharp turn in policies evident in other industrial countries – most dramatically in the U.S. In those countries, conventional 'comparative advantage' theories of trade and development have been tossed aside in favour of powerful pro-active interventions aimed at expanding the domestic presence of renewable energy innovation and manufacturing. In particular, the Biden Administration's deceptively named Inflation Reduction Act (IRA) constitutes an historic new chapter in U.S. economic history. Its massive set of subsidies, grants, incentives, and direct public investments in all dimensions of renewable energy production and use – including powerful incentives for domestic manufacturing of renewable energy technologies, components, and equipment – is remaking global competition. Its impacts are already visible in astounding changes in the location of manufacturing investment, the pace of energy innovation, and the take-up of new renewable energy technologies.

This historic shift in U.S. policy is a hopeful sign for the global environment: if sustained, it would make the U.S. (currently one of the world's worst carbon polluters) an environmental leader. But it also poses fundamental challenges to other countries, because the lure of U.S. incentives will redirect investment and production from elsewhere. Many other industrial countries are responding quickly to this new policy environment with massive programs of their own. Australia, so far, has been slow to react.

For Australia to capture the full benefits of the accelerating global energy transition, we will need to shake off the legacy of years of orthodox policy that accepted our status as the world's 'quarry' as a natural, inevitable result. There is a vast range of industrial benefits to be captured from the energy revolution: both in producing manufactured inputs to renewable energy projects, and in developing a new, sustainable generation of manufacturing that uses renewable energy as a clean power source. Those spill-over linkages could provide Australian manufacturing with new vitality, after decades of policy neglect and painful contraction. But to seize that opportunity will require government to intervene forcefully with active measures that proportionately match the force of the IRA, while addressing Australia's unique constellation of attributes and barriers with tailored policy supports.

This paper will consider the opportunities and challenges posed to Australian manufacturing by the global energy transition, and the dramatic shift in global industrial policy making. The first major section considers the theory and practice of industrial policy, including its application to the industrial opportunities associated with the energy revolution. The second section catalogues the dramatic advances in climate industrial policy occurring around the world: including the U.S., but in competing jurisdictions too (such as China, the EU, Japan, Korea, and Canada). This

review confirms that Australia will be left out of this race to nurture sustainable manufacturing activities without a proportionate response. The third section reviews Australia's initiatives in renewable energy and related manufacturing so far, finding them to be halting and modest. In particular, there has been no sustained effort to support the development of domestic manufacturing activity related to renewable energy systems.

The fourth and final section describes what will be required in a more effective Australian response: in terms of both quantitative scale and qualitative features. It concludes that to match the general impact of the U.S. IRA, Australia would need to commit between $83 and $138 billion in fiscal supports for renewable energy-related manufacturing over the next decade. While that is a sizeable investment by any measure, it is comparable to other commitments being made by the Commonwealth government (including to nuclear submarines, Stage 3 tax cuts, and ongoing subsidies to fossil fuel industries). More important, it would lay the groundwork for an historic reorientation of Australian economic development policy: instead of focusing primarily on extracting unprocessed resources that are sold to other countries (who in turn convert them into value-added products that are sold back to Australians), Australia could take the opportunity provided by the renewable energy revolution to carve a more fulsome and diversified role in global value chains – one that makes the most of our enviable resource base.

# 1. The Theory and Practice of Climate Industrial Policy

Put simply, industrial policy is the robust use of government policy to shape the structure of an economy: that is, the presence and size of desired industries, technologies, and capacities within an economy.[6] Accordingly, climate industrial policy is the implementation of industrial policies to respond to the challenge of the climate crisis: shaping the structure of the economy away from carbon intensive activities and supporting industries and technologies to facilitate decarbonisation.[7]

A particular focus of climate industrial policy is to use new investments in renewable energy production as a platform for supporting the expansion of related manufacturing activity. In this regard, two broad classes of spill-over linkages between renewable energy and manufacturing are possible:

1. The production of manufactured products, materials, and technologies that are utilised in renewable energy generation projects and systems (including equipment and manufactured materials necessary for solar, wind, geothermal, and hydro generation projects; and the manufacture of other technologies which incorporate renewable energy technologies, such as electric vehicles).
2. The use of renewable energy as an input to other manufacturing activities, in order to reduce their environmental footprint and make them consistent with climate policy targets (including the reorientation of traditional manufacturing activities around renewable energy sources such as steel-making, metal fabrication, and aluminium smelting; and the development of entirely new manufacturing products and processes dependent on abundant renewable energy, such as clean hydrogen).

The general goal of industrial policy is to increase the presence of and benefits from particularly desirable sectors and activities. The term 'industrial policy' seems to imply a focus on heavy industrial facilities, but this association is no longer valid given the emergence of other forms of innovative tradeable industries (including specialised, smaller scale manufacturing activity, technology services, business services, and others). Instead, a more general conception of industrial policy focuses on key

[6] The definition of this term is a matter of ongoing debate and confusion. See Stiglitz, Lin, and Monga (2013); Rodrik (2008); Dean et al. (2020).

[7] This has elsewhere been referred to as green industry policy (see Rodrik, 2014; Allan, Lewis, and Oatley 2021) or green industrial strategy (see Bigger and Strecker, 2023).

qualitative characteristics of desirable sectors, rather than limiting its attention to traditional heavy manufacturing.[8] These characteristics would include:

- export-orientation (such that a greater domestic presence leads automatically to stronger balance-of-payments performance)
- technology-intensity (thus supporting strong domestic innovation capacities and spillovers)
- high productivity and potential for future productivity growth (thus underpinning high and rising living standards over time), and
- the ability of a sector to anchor strong and complex domestic supply chains (thus ensuring significant spin-off economic activities through both upstream and downstream interactions).

These characteristics apply to many different tradeable industries, in the primary, secondary, and tertiary spheres of the economy.

There are many policy levers in the 'toolbox' of industrial policy, that can be applied to the goals of climate industrial policy. These include, though are not limited to:

- Low interest loans
- Subsidies
- Underwriting and guaranteeing investments
- Direct investments
- Trade policy
- Regulations
- Public procurement strategies
- Equity investments
- Public provision of low-carbon goods and services
- Financing clean technologies via public banks
- Price controls

For several decades after the 1980s, industrial policy became largely unfashionable amongst economic policymakers, particularly in the West and amongst international economic institutions. Remarkably, only a few years ago industrial policy was even described by the International Monetary Fund (IMF) as "the policy that shall not be named."[9] Informed by 'neoliberal' and 'economic rationalist' theories, governments were advised not to pick economic 'winners and losers' through active measures to

[8] For these reasons, Stanford (2012) suggests that the term 'sector development strategies' is a more appropriate moniker for this set of policies, rather than 'industrial policy.'

[9] Cherif and Hasanov (2019).

favour particular sectors.[10] Instead, supposedly neutral market forces and business decisions were to be placed in charge of determining the sectoral structure of economies. This hands-off approach led to a hollowing out of the industrial bases of many developed economies – a structural weakness brought into sharp focus by the COVID-19 pandemic.[11]

Australia suffered from this neglect of sectoral policy to an extreme degree: the decline of Australian manufacturing was severe in both quantitative and qualitative terms. Today Australia has the smallest manufacturing sector relative to GDP, and the greatest net reliance on imported manufactures, of any OECD country.[12]

Some influential voices in Australian policy debates continue to support this orthodox, hands-off approach to industrial and sectoral issues. For example, the Productivity Commission, in its most recent review of trade policies, issued a renewed call for Australia to refrain from pro-active policies to support the domestic growth of renewable energy manufacturing (such as batteries, EVs, and other rapidly growing industries). Instead, the country should follow its 'comparative advantage' in extraction of resources. While other countries race to support high-technology manufacturing activities, Australia should focus on doing what it does best: namely, digging minerals out of the ground and selling them to other countries, which then manufacture them into expensive value-added products (some of which are sold back to Australia):

> "The comparative advantage of nations is principally a function of their endowments – their workforces, their natural resources, their stock of physical capital etc – and the presence of institutions that enable the realisation of their potential… The comparative advantage in resource extraction presented by Australia's resource endowments is more suggestive of a comparative advantage in the processing of low concentration minerals than in final battery production."[13]

This view, thankfully, is falling from global favour – though it still holds considerable sway in Australia. As this report will show, industrial policy is experiencing a dramatic global resurgence, and climate-oriented industrial policies are propelling this rejuvenation. This marked global re-embrace of pro-active industrial policy is the result of several intersecting economic and political factors:

[10] *The Economist* (2022); Bulfone (2023).

[11] The effects of this in Australia are discussed in Stanford (2020a).

[12] Stanford (2020a).

[13] Productivity Commission (2023), pp. 77-78.

Firstly, the prolonged fallout from the Global Financial Crisis (GFC) through the 2010s led to widespread stagnation in living conditions, low wage growth, sluggish investment, and rising inequality across many major economies.[14] This played a significant role in inspiring populist political waves which unsettled democratic political systems in many states, and brought global governance architectures into question.[15]

Secondly, awareness of the scale of the climate crisis has grown steadily, particularly as efforts following the Paris Accords to stay within 1.5 degrees of warming appear to have failed.[16] Free market and regulatory approaches to decarbonisation have proved ineffective at stemming emissions. According to the latest report of the Intergovernmental Panel on Climate Change (IPCC), the world continues to accelerate towards climate disaster.[17] This will not change without the rapid decarbonisation of the economic sectors accounting for most greenhouse gas emissions: agriculture, transport, housing, energy, and manufacturing – in short, a systemic economic transformation.[18] Such a transformation clearly needs active guidance from policy, rather than being achieved through autonomous market forces (even in the context of policies to 'perfect' those markets, such as carbon pricing policies).

Thirdly, the rise of comprehensive alternative policy visions, such as the Green New Deal (GND), has created a political vocabulary to describe the scale of the change required to address the climate crisis.[19] The GND drew parallels between the scale of transformation required to address the climate crisis with the economic mobilisation undertaken by the United States following the Great Depression and through the Second World War, and was taken up as a political demand in throughout the world.[20] While its campaigners were unsuccessful in achieving the full breadth of the GND's ambitions, the proposal was decisive in opening the political space in which the compromise vision of the IRA could succeed.[21]

Fourthly, the global shifts brought about by the economic and geopolitical rise of China, exemplified by Chinese success in developing renewable technology and semiconductor manufacturing capacity, reinforced the new openness to active industrial strategies.[22] While developed economies in the West were reluctant to

[14] Chen, Mrkaic, and Nabar (2019); Kalleberg and Wachter (2018).
[15] See Tooze (2019).
[16] Osaka (2023).
[17] IPCC (2023).
[18] Krishnan, et al. (2022).
[19] McNamara (2022) described these as "aspirational politics."
[20] See Tienhaara and Robinson (2021).
[21] Aronoff (2023).
[22] Mazzocco (2022).

deploy industrial policies through the neoliberal era, the Chinese government successfully utilised industrial policies, state planning, and public investment to rapidly develop China's industrial and technological base. This contributed to the growing economic and political hostility to China by the United States and its allies, and has been a central factor in motivating the American embrace of industrial policy.[23]

Fifthly, the experience of the COVID-19 pandemic brought the weakness of global supply chains into focus, legitimised major government economic intervention, and was seen by many as a sort of 'dress rehearsal' for the larger crises brought by climate change.[24] In its aftermath, governments around the world have pledged to strengthen their supply chains and 're-shore' manufacturing capacity.[25]

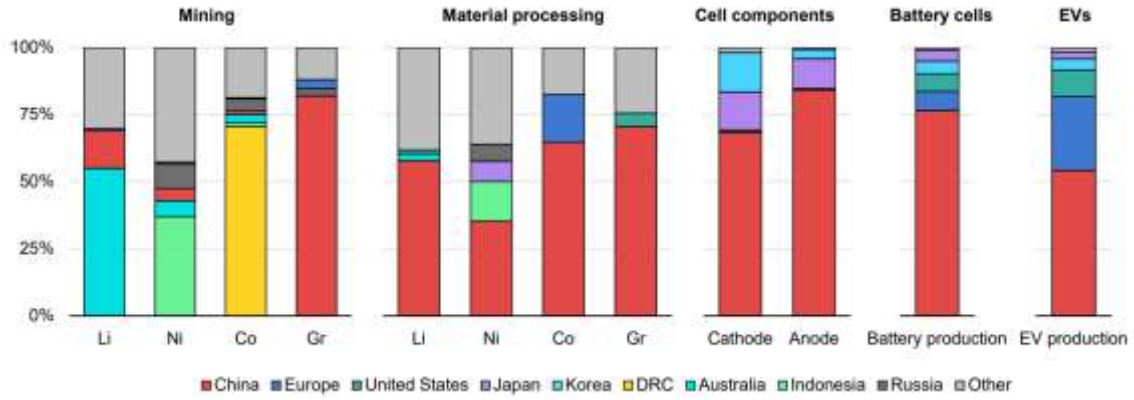
Finally, the Russian invasion of Ukraine in March 2022 sent shockwaves through global energy markets, as supply shifts and market speculation led to soaring energy prices across the world. This amplified calls to decouple from reliance on fossil fuels and accelerate the transition to renewable energy.[26]

The acceleration of the global energy transition, combined with the simultaneous adoption of a newly interventionist approach to industrial policy-making, serve to highlight both Australia's opportunities and challenges. Australia possesses one of the richest endowments of renewable energy capacity, thanks to its land mass, sunshine, and wind. It also possesses enormous reserves of lithium and many other of the critical minerals in increasing demand for renewable energy systems and technologies. However, at this point, Australia's footprint in the global renewable energy value chain is limited almost exclusively to the very bottom: extraction and export of those resources.

For example, Figure 1 (prepared by the International Energy Agency) strikingly illustrates the uneven geographical location of various segments in the supply chain culminating in global production of EVs – which will soon dominate new vehicle markets around the world. Australia (lightest blue bars) dominates world lithium production, accounting for over 50% of total supply in 2021. Australia has smaller but still visible slices of other critical minerals (including nickel and cobalt). But Australia is not visible in the rest of the chart – because Australia has no capacity to speak of in converting its own minerals into value-added products, from processed minerals to cell components and batteries (let alone to mass-produce passenger vehicles, which has not occurred in Australia since 2016).

[23] See Sullivan (2023) and Yellen (2023).
[24] See Goldberg (2021) and Stansfield (2020).
[25] Investment Monitor (2023); European Union (2021).
[26] IEA (2023).

**Figure 1. Geographical Distribution of the Global EV Supply Chain**




Source: International Energy Agency (2022, p.5)

Without a deliberate and powerful strategy to transform its role in global trade and investment decisions, the net effect of the renewable energy revolution for Australia may culminate in simply replacing one set of non-renewable resources exported to the rest of the world (fossil fuels) with another (lithium and other critical minerals). That would squander the many potential benefits of a more fulsome and diversified economic strategy.

The remainder of this paper will catalogue the efforts by the U.S. and other industrial countries to capture the industrial spill-over benefits of the energy revolution through ambitious, pro-active strategies to nurture manufacturing activities related to renewable energy. That ambition will be contrasted with Australia's approach, still heavily influenced by orthodox 'comparative advantage' thinking. The paper concludes with recommendations for how Australia needs to match the quantitative scale of interventions being undertaken in the U.S. and elsewhere, and adopt best practices to make those interventions most effective given Australia's unique attributes and challenges.

# 2. The Shifting Goalposts of Global Climate Industrial Policy

## USA

Once the dominant manufacturing industrial power, decades of free trade and *laissez faire* economic policies hollowed out US manufacturing capacity – provoking significant political backlash. Responding to deindustrialisation, the geopolitical and economic challenge of China, and the supply chain weaknesses exposed by the COVID-19 pandemic, the Biden administration has embarked on an ambitious push to revive domestic manufacturing and simultaneously decarbonise the US economy.

Towards this end, the administration has embraced aggressive climate industrial policy: principally, through the historic **Inflation Reduction Act (IRA).**

**Key Policy Frameworks**

The Inflation Reduction Act (IRA) was enacted in August 2022. While the legislation is multifaceted – some provisions are dedicated to debt reduction and lowering prescription drug prices – the central goal of the IRA is to reindustrialise the United States and accelerate the country's decarbonisation effort. President Biden has pronounced the IRA as both "the largest investment ever in clean energy" and "the largest investment in American manufacturing".[27] The IRA's provisions alone are predicted to facilitate a 43% reduction in US carbon emissions by 2030 compared with 2005 levels.[28]

The Inflation Reduction Act relies on tax credits and subsidies as principal policy instruments, aiming to drive private sector investment in clean electricity and vehicle manufacturing. The legislation announced $391 billion on energy and climate change provisions, though independent research estimates this may rise to $1.2 trillion. This is estimated to pave the way for some $3 trillion of private capital investment in renewable technology and manufacturing.[29]

Additionally, a central tenet of the IRA is the 'on-shoring' of clean technology industries, aiming to rebuild US domestic manufacturing capacity. Significant tax

[27] Deese (2023).
[28] Energy Innovation (2022).
[29] Saul (2023).

credits are also devoted to the purchase of domestically-produced electric vehicles (EVs): $7,500 is offered to purchasers of electric vehicles assembled in North America. In order to strengthen investor confidence, the legislation sets out a long-term industrial roadmap: eligibility these tax credits is set to tighten as further requirements are placed on materials and components sourcing for EV batteries. By 2028, 100% of subsidised EV battery component parts must be sourced in North America, and by 2026 80% of critical minerals used in EV battery production must be extracted, processed, or recycled in North America or in countries that have free trade agreements with the U.S.[30]

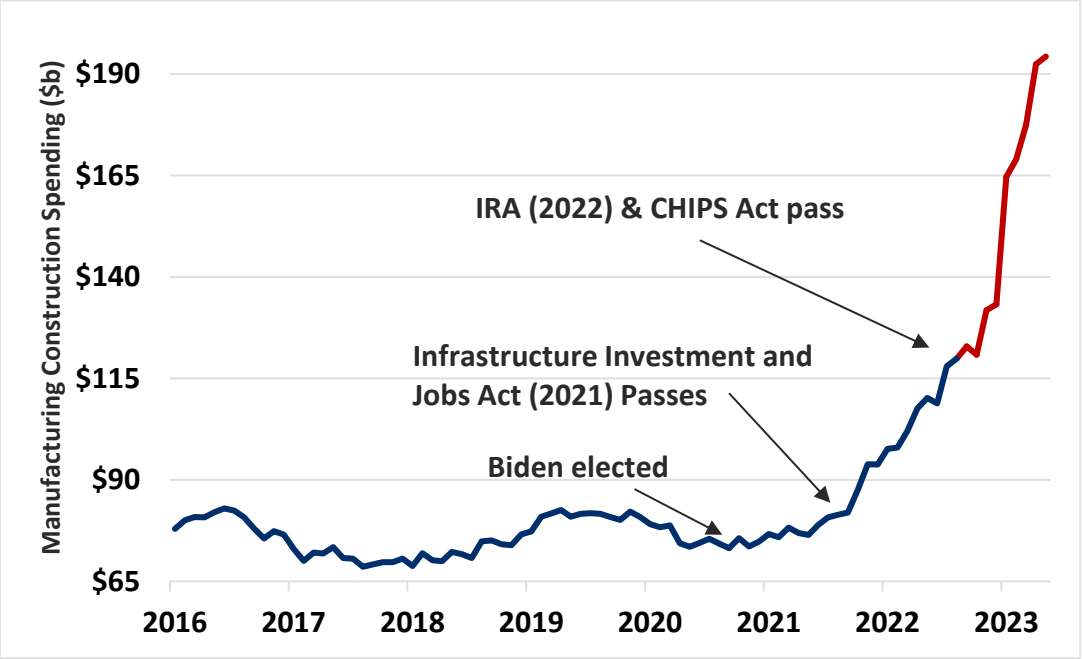
The incorporation of U.S.-aligned foreign economies into new US-led clean tech supply chains, often referred to as 'friend-shoring', reflects the U.S. government's growing concern about America's economic dependence on China.[31] As China currently dominates global renewable energy supply chains, this 'friend-shoring' will likely spark substantial global economic tumult. This is of particular concern to the international critical minerals industry. China dominates the processing of critical minerals: 90% of rare-earth elements and 60-70% of lithium and cobalt are refined in China.[32] For primary producers of critical minerals to substantially benefit from the IRA subsidies (such as Australia, the largest primary producer of lithium), the processing of these minerals must be undertaken in U.S.-aligned economies.

**Results**

Since passing less than a year ago, the IRA has already had a remarkable impact. Climate Power calculated that in the first six months since the Inflation Reduction Act's passing, 100,000 new clean energy jobs had been created in the US from over 90 new clean energy projects.[33] Between August 2022 – when the IRA and the CHIPS Act (promoting semiconductor manufacturing) passed – and April 2023, investment in clean tech and semiconductor manufacturing doubled.[34] As shown in Figure 2**, real** spending on manufacturing construction rose has more than doubled in the last two years.

[30] Baldwin (2022).
[31] Benson and Kapstein (2023).
[32] IEA (2023), p. 82.
[33] Climate Power (2023).
[34] Chu and Roeder (2023).

**Figure 2: Manufacturing Construction Spending in the United States**




Source: St. Louis Federal Reserve Bank, FRED Database.

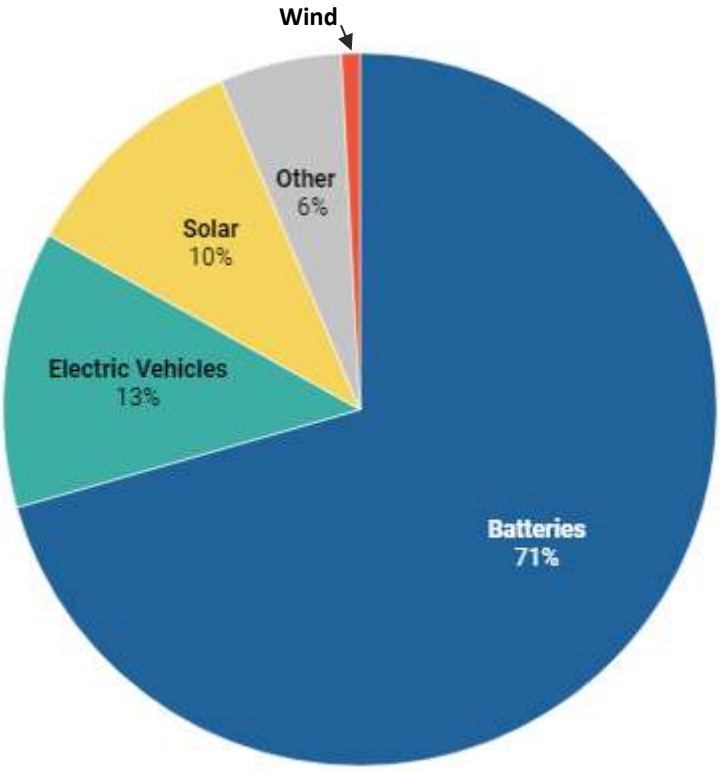
This rapid expansion in US clean technology manufacturing is set to continue. Recent analysis from the BlueGreen Alliance and the Political Economy Research Institute at the University of Massachusetts Amherst predicts that 9 million clean energy and climate-related jobs will be created over the next decade – with 900,000 of them in clean manufacturing alone.[35]

This massive expansion in clean tech manufacturing capacity prepares the United States to not just decarbonise its own economy, but to emerge as a powerful global supplier of the technology and equipment necessary for renewable energy development in other countries. The IRA alone is estimated to cause up to a 25% reduction in the cost of clean energy technologies by 2030.[36] Further, the impact of IRA subsidies is already leading to countermeasures from economic competitors (which this report explores), and this is likely to grow. That will reinforce the acceleration of global decarbonisation.

[35] BlueGreen Alliance (2022).

[36] Boston Consulting Group (2022).

**Figure 3: Total IRA Dollars by Investment Type**




Source: Conness (2023).

However, some problems with the IRA's model of investment incentives have emerged. By driving private sector clean technology investment, the IRA ensures that investment is motivated by profit, not decarbonisation – effecting a potentially disorderly and ineffective decarbonisation.[37] Between August 2022 and May 2023, the IRA spurred US$69 billion in investment, but only ten percent of this has been into renewable energy; the overwhelming majority has flowed to batteries and electric vehicles (see Figure 3).[38] Private sector investment ultimately flows to what is most profitable, and this is not necessarily what is most environmentally and emissions friendly. This dilemma is now playing out in US EV manufacturing, where IRA-subsidised auto manufacturers are choosing to build larger, more expensive, and ultimately more profitable EV trucks instead of smaller, more affordable vehicles.[39]

Gabor (2023) has been critical of the IRA's market-led decarbonisation model. She has argued that this model of 'de-risking' climate-friendly private investment threatens to derail other climate policy pathways which prioritise penalising emitters.[40] Further, she

[37] Gabor (2023).
[38] Conness (2023).
[39] Aronoff (2023a).
[40] Gabor (2023).

argues that far from the pronouncements of the death of neoliberalism,[41] the IRA works to empower private asset-manager capital, yielding public control over the decarbonising transition, and additionally may lead to artificial profit-driven inflations in the price of renewable energy.[42]

Nevertheless, the IRA does contain provisions empowering public-sector investment. The IRA's 'direct-pay' provisions allow tax-exempt entities, such as state and municipal governments, to receive clean energy tax credits in the form of direct transfers.[43] With no formal cap on direct transfers, this empowers governments to invest in publicly-owned clean technology – particularly (though certainly not limited to) electricity generation.

The Inflation Reduction Act is ultimately an historic paradigm shift in US and global climate policy. In providing massive subsidies for clean technology companies to invest in the United States, the IRA throws down the gauntlet for other states to respond – and, as discussed below, those responses have already begun.

# CHINA

The Inflation Reduction Act was not just a response to the climate emergency and domestic political backlashes resulting from deindustrialisation; it also reflected a widespread concern that the United States was rapidly being outpaced by China in clean technology development and manufacturing.

Through active industrial policies, state planning, and public investment, the Chinese government has taken world-leading steps in developing renewable technology manufacturing capacity. For example, thanks to its fast start and sustained, powerful industrial strategies, China has developed a dominant position in all downstream segments of EV manufacturing: from processing on material inputs, to assembly of battery components and batteries, to the design and assembly of EVs (see Table 1). China has achieved similarly world-leading prowess in other renewable energy systems and manufacturing. This success is the culmination of over a decade of focused, multi-faceted, internally consistent industrial strategy.[44] Indeed, Chinese investment in energy transition technology has vastly outstripped that of other nations. According to BloombergNEF, Chinese investment in clean technology manufacturing capacity is

[41] See Sullivan (2023); Wallace-Wells (2023).
[42] See also Lawrence (2022).
[43] Lala (2023).
[44] Jin, Lingzhi, et al. (2020).

between eight and ten times greater than North America and Europe combined.[45] Moreover, this manufacturing activity is only a portion of the $546 billion which China invested into its overall renewable energy transition in 2022.[46]

| Table 1<br>China Market Share EV Supply Chain, 2021 | |
|---|---|
| **Lithium-ion batteries** | 77% |
| **Cathodes** | 70% |
| **Anodes** | 85% |
| **Lithium, Cobalt, Graphite processing** | >50% |
| **EV assembly** | >50% |
| Source: Adapted from IEA (2022). | |

**Key Policy Frameworks**

As the largest overall national carbon emitter, the Chinese transition to net-zero is an enormous economic and industrial undertaking, with significant opportunities for China's manufacturing sector – and for global environmental well-being.

Manufacturing is the central pillar of China's modern economy. The sector has powered China's rapid economic development since 1978 and accounts for 27.4% of GDP as of 2021.[47] With over 30% of total global manufacturing, China possesses the world's largest manufacturing industry.[48]

Over the past decade, the Chinese government has implemented several landmark policy frameworks which place green technology manufacturing at the centre of China's economic strategy. The landmark state industrial plan **Made in China 2025 (MIC25)** declared green manufacturing as one of five national development priorities. Launching in 2015, MIC25 is a comprehensive industrial policy framework, aiming to develop China's manufacturing sector away from being the 'world's factory' – mass producing low-tech export goods – towards high-tech and integrated manufacturing industry.[49] The plan relies on direct state interventions, including funding research and

[45] Bullard (2023).
[46] BloombergNEF (2023).
[47] UN Stats (2021).
[48] Ibid
[49] Agarwala and Chaudhary (2021), p.426.

development and the creation of manufacturing innovation centres, as well as market mechanisms such as regulation and the strengthening of intellectual property rights.[50] For aiming to make China a high-tech manufacturing power, Made in China 2025 has been described as a "frontal challenge to advanced manufacturing in the US, Europe, and East Asia."[51]

Successive **Five-Year Plans (FYPs)** – China's traditional form of state economic planning – have also prioritised green manufacturing. Since 2001, all Five-Year Plans have promoted domestic solar technology supply chains through various mechanisms and incentives, considering solar technology as an emerging strategic sector.[52] The **13th FYP** (2016-2020) promoted the ideological framework of an 'Ecological Civilisation', which established environmental sustainability as a core priority of China's development. Likewise, the **14th FYP** (2021-2025) represents a comprehensive green development policy framework. The plan declares peak emissions shall be reached no later than 2030, and carbon neutrality will be achieved before 2060. It also calls for half of vehicles to be electric or fuel-cell powered, and the other half hybrid, by 2035 – meaning petrol engine vehicles will be effectively phased out in new vehicles by 2035.

China has also been forced to reckon with the longstanding carbon and energy intensity of its manufacturing sector.[53] In response, several key policy frameworks have recently been initiated to facilitate energy conservation and carbon reduction in intensive industries, including 'Carbon peaking for steel sector' (2022), 'Plan for the Development of Hydrogen Energy Industry' (2022), 'Standards 2035 Plan' (2022), and the '2025 Energy Efficiency Targets for Key Polluting Industries' (2022). These policy frameworks set national targets and standards and provide policy support to affected sectors. They are also augmented by China's Emissions Trading Scheme, launched in 2020, which utilises carbon credit and taxation schemes to accelerate the climate transformation of multiple industries including manufacturing.[54]

**Results**

China's comprehensive and longstanding climate industrial policies have delivered results. Today, China is the leading global supplier of clean energy technologies.[55] China holds at least 60% of the world's manufacturing capacity for most mass-manufactured clean technologies, including solar panels, wind systems, and batteries,

[50] Kennedy (2015).
[51] Ibid
[52] IEA (2023).
[53] Shen & Lin (2020), p.1.
[54] Luyue (2022).
[55] IEA (2023).

as well as 40% of electrolyser manufacturing.[56] Moreover, near two-thirds of the world's batteries for electric cars and almost three-quarters of all solar modules are currently produced in China, according to the International Energy Agency.[57] In 2022, China accounted for the majority of investment in renewable technology factories necessary for the global energy transition.[58] Furthermore, China's domestic emissions reduction targets have also created a strong domestic market for renewable energy technology, fostering innovation and investment.

# EUROPEAN UNION

The willingness for the United States to join China in embracing climate industrial policy through the Inflation Reduction Act has unnerved many US international allies, including the European Union (EU). Several EU leaders are concerned that the massive subsidies unleashed by the legislation will encourage clean technology companies to relocate to the United States, undermining both the bloc's economy and decarbonisation efforts. Nevertheless, the EU retains its own strong climate ambitions, seeking to cut emissions by 42.5% by 2030 and for Europe to be the first climate neutral continent by 2050. Accordingly, the bloc has implemented and proposed several decarbonisation policy frameworks and investment plans that are consequential for European green manufacturing.

**Key Policy Frameworks**

Responding to the accelerating global green manufacturing subsidy race, the EU has recently formulated the **'Green Deal Industrial Plan'**. This proposal expands on the existing **European Green Deal**, a policy framework and funding strategy announced in 2019 which provides a framework for Europe to reach net-zero GHG emissions by 2050.

The Green Deal Industrial Plan contains two central proposals: the **Net-Zero Industry Act (NZIA)** and the **Critical Raw Minerals Act (CRMA).** Together, these proposals aim to provide a framework through which the EU can secure its supply of green technologies required for the bloc's climate transition, as well as the critical raw minerals necessary to build them.[59]

The NZIA stipulates that at least 40% of the green technology required to meet the EU's climate and energy targets should be made in Europe by 2030. This includes EU

[56] IEA (2023).
[57] Ibid
[58] Ibid
[59] Zimmerman and Di Sario (2023).

manufacturers producing 40% of annual solar PV deployment, 50% of electrolysers, and 60% of heat pump deployment by 2030. These targets are reflective of broader momentum within the EU to strengthen Europe's manufacturing base, after the COVID-19 pandemic exposed Europe's dependence on suddenly unreliable imported medical goods.[60]

Additionally, as part of the GDIP, the European Commission has announced the creation of a **European Hydrogen Bank** to boost investment in renewable hydrogen. The bank aims to bridge the commercial gap between green hydrogen's production cost and its market value, as well as stimulating a European green hydrogen international import market.[61] It is set to be operational by the end of 2023.

The GDIP builds on other recently instituted EU green industrial support. Following the Russian invasion of Ukraine in February 2022, the EU has rapidly sought to decouple its dependence on Russian oil and gas supply. The framework for this transition is **REPowerEU**: a plan to secure Europe's energy supply by reducing dependence on Russian fossil fuels and accelerating the climate transition.[62] As well as facilitating increased investment in renewable energy capacity, REPowerEU aims to improve energy efficiency, particularly in industrial processes. The plan utilises the existing post-Covid **Recovery and Resilience Facility**: a funding instrument through which EU member states can access finance for post-pandemic economic and social recovery. By utilising existing grant application and assessment channels, the plan intends to fast-track approximately €268 billion in funding for clean technology development, energy efficiency schemes, and workforce development.[63] REPowerEU has had impressive early successes, with renewable energy investments in Europe accelerating significantly since the Russian-Ukraine War.[64]

In July 2023 the European parliament gave final approval to the **European Chips Act**, a clear response to the eponymous US policy. It will support an estimated €43 billion of investment in the EU through 2030.[65] A range of measures are contained in the package, including Investments in next-generation technologies, access to design tools and pilot lines for the prototyping, certification procedures for energy-efficient and trusted chips, and a streamlined regulatory framework for establishing microchip manufacturing facilities in Europe.

[60] Rankin (2023).
[61] European Commission (2023a).
[62] European Council (2023).
[63] Ibid
[64] IEA (2023).
[65] European Commission (2023b).

Further European measures appear forthcoming, including the further loosening of state aid rules: long-standing EU prohibitions against direct state support for industry. Additionally, to support climate industrial policy initiatives, the EU Commission has proposed the creation of an **EU Sovereignty Fund** to fund technological development and manufacturing capacity within the bloc.[66] However, this Fund has provoked opposition and its future is uncertain.[67]

Within the EU, several member states are also embarking on state-level climate industrial policy initiatives of their own, which amplify the impact of bloc-wide policy interventions. The French government has announced **France 2030**, a €30 billion investment plan to reindustrialise France by creating tech 'champion' firms in sectors including electric vehicles, nuclear, and renewable energy.[68] Likewise, the German government has recently unveiled a €1 billion fund to fund green and 'deep' technology development and commercialisation.[69]

# JAPAN

The Japanese government has initiated major policy initiatives in recent years to embrace the economic opportunities of the renewable energy transition. In line with its Paris Accord commitments, Japan has set targets of a 46 per cent reductions in greenhouse gas emissions by 2030, and carbon neutrality by 2050. Major industrial strategies have also been formulated to guide Japanese policymakers and foster green growth, reflecting Japan's long-standing practice of state industrial policy. However, Japan also faces several obstacles in fully realising the opportunities of the clean energy revolution.

### Key Policy Frameworks

The Japanese state has played an integral role in fostering Japan's post-war economic success. Following the Second World War, successive governments instituted active industrial policies, through which subsidies and regulation fostered an economic transformation from agriculture to manufacturing and from 'light' industries (e.g. textiles) to heavy industries (e.g. steel and automobiles).[70] This fostered the rapid rise of Japan's manufacturing export industries in the decades following the Second World War, powering Japan to the status of second largest economy in the world by 1968.[71]

[66] Breton (2022).
[67] Matthews (2023).
[68] Pelé (2021).
[69] Hammadi (2023).
[70] Krugman (1991).
[71] Berkeley Economic Review (2023).

Due to this experience, Japan is well-placed to successfully implement a new generation of climate industrial policies.[72]

To achieve national decarbonisation goals, the Japanese government has formulated the **Green Development Strategy through Achieving Carbon Neutrality in 2050**. Fourteen economic sectors are expected to grow through decarbonisation, which the strategy separates into three overarching categories: energy-related industries, transport and manufacturing industries, and home and office-related industries. The strategy utilises a combination of grants, public-private partnerships, strategic procurement, and regulatory changes to stimulate innovation and growth in Japan's renewable and low carbon technology industries.

Integral to the Green Development Strategy is the JPY 2 trillion (approximately $16 billion U.S.) **Green Innovation Fund,** which aims to support business-led decarbonisation initiatives across priority sectors – from R&D through implementation. The Fund aims to provide ongoing, reliable support for renewable and low carbon technology businesses pursuing technology innovation.

Technological innovation is central to Japan's climate industrial strategy, reflecting the historic centrality of innovation in driving Japan's post-war economic success. This innovation has been particularly present in the manufacturing industry. In pursuit of maximising efficiency, Japanese firms have pioneered manufacturing methods that are compatible with sustainability goals. These include the 'Lean Manufacturing' approach, developed by Toyota in the 1950s, whereby waste in production processes are identified and eliminated, as well as the recycling of industrial waste products into useful resources, minimising the need for new materials.[73]

Japan's transition plan, however, has been criticised for its reliance on fossil fuel-based technologies, including liquified natural gas, ammonia co-firing in coal-fired power plants, and fossil-fuel powered hydrogen production.[74] These criticisms are not unprecedented; indeed, Japan has consistently ranked as the worst performing G7 economy across multiple indicators of climate policy progress.[75] Its renewable energy industry remains limited, with Japan still expecting to draw over 40 per cent of its power from fossil fuels by 2030 and several new coal power plants under construction across the country.

[72] See also: Mathews et al. (2021).
[73] Japan Industry News (2023).
[74] Sawung and Arances (2023).
[75] Littlecott et al. (2023).

# KOREA

Like Japan, South Korea's state has successfully used long-term strategic economic development planning to achieve the country's transformation into a manufacturing-based export-oriented economy (Amsden, 1992). However, this growth came with severe environmental cost. South Korea has long been dependent on imported fossil fuels and is a large carbon emitter, giving the state a reputation as an "environmental laggard".[76]

However, perhaps paradoxically, South Korea has nevertheless been a pioneer of 'green growth', having initially endorsed the concept in its post-GFC stimulus plan.[77] The state now seeks to more completely embrace the economic opportunities of decarbonisation through its landmark **Korean New Deal.**

**Key Policy Frameworks**

In response to the massive economic contractions caused by the COVID-19 pandemic, in 2020, the South Korean government announced the **Korean New Deal (KND).**[78] The KND is an overarching techno-industrial strategy, aiming to establish South Korea as a world leader in emerging technology-intensive, higher-skilled, higher-wage, export-oriented industries.[79] It encompasses an overall KRW 160 trillion (US$135 billion) in investments, with US$96.3 billion from the Korean Treasury, US$21.2 billion from local government, and US$17.3 billion from the private sector. The Korean government estimated the plan would create 1.9 million jobs by 2025.

The KND has two central pillars: a **Digital New Deal** and a **Green New Deal (GND)**, as well as several policies to strengthen South Korea's welfare system. With KRW 73.4 trillion for 'green' investments in the period 2020-2025, this GND was more substantial than its post-GFC counterpart. The plan signals a clear shift away from coal and nuclear power and towards renewable energy development. KRW 24.3 trillion is devoted to low-carbon and decentralised energy, including KRW 13.1 trillion for expanding the supply of electric and hydrogen vehicles. The plan aims for Korea to have 1.13 million electric vehicles and 200,000 hydrogen vehicles on Korean roads by 2025, creating a domestic market for electric car manufacturers, and will install 45,000 EV charging stations and 450 hydrogen refuelling units.

[76] Tienhaara, Yun, and Gunderson (2021).
[77] World Bank (2012).
[78] Kim et al. (2020).
[79] Thurbon et al. (2022).

Like Japan, South Korea is prioritising hydrogen development, investing significantly through the GND in hydrogen fuel cell EVs and hydrogen refuelling infrastructure. This builds off the **Hydrogen Economy Roadmap**: a landmark hydrogen industry strategy, announced in 2019, to transition the state-owned utility KOGAS from a natural gas supplier into a hydrogen platform operator. However, the Korean government is not mandating the production of green hydrogen, and there is currently no concrete plan to transition from existing 'grey' hydrogen capacity (based on natural gas) to clean hydrogen. For this reason, many observers doubt the efficacy of South Korea's hydrogen investment at effectively decreasing emissions.[80]

As well, the GND encourages circular economy initiatives such as energy and materials reduction and recycling through computerised power grids in factories, as well as carbon capture and storage in industrial processes. The GND also provides KRW 7.3 trillion for green industrial innovation through development support grants, public-private partnerships, and loans.

While the KND has garnered significant praise, many domestic and international observers have criticised the plan for not going far enough. The law firm Clifford Chance has posited that the government's hydrogen strategy "appears to be driven more by the perceived opportunities for economic growth and industrial competitiveness than by climate change objectives."[81]

Interestingly, this is not the first time South Korea has had a policy framework called the Green New Deal. In 2009, following the Global Financial Crisis, the South Korean Government of Lee Myung-bak unveiled the **Korean Green New Deal (KGND)**, making the country the first to adopt a policy under this banner. The KGND amounted to a KRW 50 trillion (US$38 billion) stimulus package, with KRW 9.65 trillion spent on green transportation and KRW 2.05 trillion on green cars and clean energy. The KGND was celebrated by some commentators as the "greenest" stimulus package in the world;[82] and the OECD Secretary-General went as far as to dub President Lee Myung-bak as "the father of green growth".[83] However, within Korea the KGND was criticised for its centrepiece 'Four Major Rivers Project', a major hydroengineering project with significant negative environmental impacts.[84]

The Russian invasion of Ukraine, and the corresponding spike in energy prices, have caused significant policy shifts in South Korea. Promisingly, coal and gas usage is slated

[80] See also: Stangarone (2020).
[81] Clifford Chance (2020).
[82] Bernard et al. (2009).
[83] Shin (2011).
[84] Tienhaara, Yun, and Gunderson (2021), p. 281.

to be reduced by 40-45% by 2030. However, the recently elected President Yoon has pledged to expand the role of nuclear power and has actually reduced renewable energy targets from 30.2% to 21.6% by 2030. This has sparked fears of reduced investment in renewables, leading to a ceding of ground to China in the clean technology economy.[85]

## CANADA

Canada possesses several unique features that position the country well for value-added participation in the global energy transition. Some of those features are similar to Australia: including abundant endowments of critical minerals (such as lithium and rare earths) that will be vital commodities in the next generation of energy manufacturing. In other ways, however, the Canadian situation differs markedly from Australia. In particular, Canada has managed to retain a large and viable automotive manufacturing industry, despite the challenges posed in recent decades by globalisation, automotive industry restructuring, and the advent of electric vehicles. This provides Canada with a strong entry point as global automotive manufacturing (and other manufacturing activities related to renewable energy) accelerates down the path to electric power.

Finally, Canada's geographic location next to the U.S., and participation in an integrated continental marketplace (through the USMCA trade agreement), is both a blessing and a threat as the energy transition unfolds. Ready access to the U.S. market serves as an important location advantage for Canadian industry. But that access works in two directions, compelling Canada to match many of the fiscal and other policy benchmarks that have been established in its much larger neighbour. The Biden administration's IRA measures, in particular, posed a profound challenge to Canada's ability to attract and retain investment in renewable energy manufacturing – one that Canadian governments (at both the federal and provincial level) have noted, and responded to.

In a landmark March 2023 federal budget, the Canadian federal government unveiled a set of fiscal programs to accelerate clean energy investments and developments in all stages of the renewable energy supply chain. The total value of newly announced supports exceeds $80 billion C over a ten-year period, broadly proportional to estimates of the combined scale of U.S. IRA measures (discussed further below). The new programs include refundable investment tax credits for investments in clean energy systems, subsidies for renewable energy manufacturing, and preferential

[85] Thurbon et al (2022); Hodgson (2023).

lending through the public **Canada Infrastructure Bank**. The budget's newly announced measures supplement other clean energy supports already in place, including a **Net Zero Accelerator** (worth $8 billion C) to support roll-out of innovative clean energy technologies and manufacturing.

Of notable importance, the Canadian strategy includes major production tax credits provided by the federal government to battery manufacturing at various sizes of production: from car batteries and other portable applications to stationary grid-capable battery systems. Not only is the size of those subsidies designed to match corresponding provisions in the U.S. IRA, but their continuation is also contingent on the U.S. maintaining its subsidies in place; if a future U.S. government were to reverse course and reduce or eliminate those subsidies, then Canadian subsidies would be retrenched in concert.

The new policy has met with quick results. Volkswagen has committed to a massive new vehicle battery manufacturing complex (its first outside of Europe) near St. Thomas, Ontario.[86] The plant is projected to produce 1 million automotive EV batteries per year once fully operational in 2027, supplying VW's rapidly growing EV assembly operations across North America. The Canadian government will provide 10% (or $700 million C) of the up-front capital costs required to build the new plant ($7 billion C), while the Ontario provincial government is contributing $500 million (C). The bigger fiscal support will be delivered through an ongoing federal production tax credit, matching the IRA's Advanced Manufacturing Production Credit.[87] Depending on Volkswagen's production volumes, that subsidy could be worth an additional $13 billion C over the next decade. The huge plant is expected to directly employ 3000 workers, and anchor a regional supply chain providing inputs and components to the facility.

Shortly afterward, the Canadian and provincial governments reached a parallel agreement with Stellantis NV (owner of the Chrysler and Fiat vehicle brands) for another mega battery manufacturing facility, to be built near Windsor.[88] The company had ceased construction of the plant (initially announced in 2022) to back up demands for production subsidies similar to those provided in the VW deal, and eventual negotiations reached a broadly equivalent deal. Again, the biggest single component of government support is the production tax credit tied to the U.S. IRA provision. The new plant will operate as a joint venture between Stellantis and LG Energy Solutions,

[86] See Office of the Parliamentary Budget Officer (2023).
[87] The production subsidy is set at $35 (U.S.) per KWh of battery produced.
[88] Shakil (2023).

and will anchor thousands of direct and indirect jobs throughout the automotive manufacturing heartland of southwest Ontario.

Numerous other battery and EV-related investments are cementing Canada's position as a leading location for this manufacturing. The Canadian and Quebec governments recently confirmed a plan with Korean battery maker POSCO for a new plant to build vehicle batteries for General Motors at Bécancour, Quebec. Government subsidies have also helped to support new Canadian investments in smaller portable battery research and manufacturing by L.M. Ericsson and Nokia. In final vehicle manufacturing, the federal and Ontario governments have also provided several billion dollars in capital subsidies to support all five of the major original equipment manufacturers present in Canada (GM, Ford, Stellantis, Toyota, and Honda) to transition their assembly facilities to produce new electric vehicle models.[89] Most recently, GM has announced a new battery module manufacturing adjunct to its EV final assembly plant in Ingersoll, which will support several hundred jobs in addition to positions in final vehicle assembly (Unifor, 2023).

Canada's tradition of activist industrial policy-making, and its relatively strong initial critical mass in automotive and other forms of manufacturing, are proving to be very advantageous in attracting these new investments. The government's industrial policy has also aimed to leverage the location advantages of Canadian lithium and other mineral deposits, which will be developed simultaneously alongside the new manufacturing investments. In all these aspects, the Canadian experience constitutes an informative reference point for Australia – a country which shares both many of the advantages of Canada (including a strong resource base and preferential trade relationships with the U.S.), and its disadvantages (an underdeveloped manufacturing base and a tradition of over-reliance on resource extraction). In Canada's case, a willingness by both federal and provincial governments to respond quickly to the challenge of the U.S. IRA, and match its overall fiscal impact (while including many Canada-specific design features) seems to be having positive results.

# OTHER COUNTRIES

Spurred on by the embrace of climate industrial policies in the United States, China, and the European Union, other governments across the world are now moving towards instituting similar frameworks.

[89] Olive (2023).

In March 2023, the British government announced the **Powering Up Britain** plan, aiming to build 'thriving green industries' and shift away from fossil fuels.[90] The plan features investments in offshore wind, renewable hydrogen, electric vehicles, and carbon capture and storage. While the plan has been celebrated for acknowledging the breadth of the problem, it has been criticised as inadequate in scale.[91]

The Indonesian government has recently taken steps to capitalise on the global climate economic transition. In 2020, President Widodo announced a ban on the export of unprocessed nickel to stimulate domestic nickel processing, and began offering incentives for Indonesian battery production.[92] Several major international companies have since opened battery manufacturing and critical mineral processing plants in Indonesia.[93] Building on these successes, the Indonesian government is now moving to incentivise domestic EV manufacturing.[94]

In April 2020, the Indian government launched the **Production Linked Incentive**: a wide-ranging manufacturing subsidy scheme aiming to boost domestic manufacturing. The scheme was expanded on in October 2022 with a US$3 billion incentive package to encourage the creation of complete solar PV manufacturing supply chains and US$2 billion to encourage domestic battery manufacturing.[95]

More recently, the Indian government is reported to be developing a major new targeted subsidy program to support the domestic development of grid-capable battery storage capacity.[96] To support the planned roll-out of 500 GW of renewable electricity capacity by end of this decade, the draft Indian plan (subject to final amendment and legislation) would provide an annual subsidy of $2.6 billion U.S. per year for companies to develop 50 GWH capacity of grid-supporting battery cells. A requirement of the plan would be that 90% of the value-added in the battery must be produced domestically. In addition to supporting the development of a domestic battery industry, the Indian government is also concerned to avoid undue dependence on long-time regional rival China for future batter supplies. In addition to direct production subsidies for battery manufacturing, the plan would also provide another $500 million U.S. in capital financing to support companies investing in the sector.

[90] UK Government (2023).
[91] Fraser (2023).
[92] Kim (2023).
[93] Mackenzie and Sahay (2023).
[94] Lee and Mokhtar (2022).
[95] IEA (2023), p. 40.
[96] Parkin (2023).

Ironically, another country which has made landmark public investments in the development of renewable energy technologies and manufacturing capacity is Saudi Arabia, the world's largest oil producer and exporter. The kingdom has mobilised many interventionist tools and sovereign wealth resources to finance a rapid expansion of renewable energy generation and related manufacturing – including plans to become the world's largest exporter of clean hydrogen (in hopes of replacing its current economic dependence on fossil fuel exports). The sovereign **Public Investment Fund** will finance $270 billion U.S. in new investments in solar and wind power generation, and complementary downstream manufacturing.[97] Saudi Arabia's **Vision 2030** program set a goal of generating half of the country's electricity from renewable sources by 2030. The neighbouring United Arab Emirates has launched a similarly ambitious $163 billion U.S. state-financed program to expand renewable energy production and use, in support of its plan to meet a net zero emissions target by 2050.[98]

[97] Economist Intelligence Unit (2023).

[98] Muzoriwa (2023).

# 3. The Current State of Climate Industrial Policy in Australia

The climate transition and renewable energy revolution provide significant opportunities and numerous challenges for Australia. Australia's economy is highly carbon-intensive; on a per-capita basis, Australia emits more carbon dioxide ($CO_2$) than any other major industrial country.[99] Australia is also the third-largest global exporter of fossil fuels, directly facilitating overseas carbon emissions.[100] As such, the decarbonisation of the Australian and global economy will necessitate significant technological and economic changes.

Nevertheless, Australia remains well placed to take advantage of the renewable energy revolution, possessing remarkable advantages in the development of renewable energy technology industries. Professor Ross Garnaut notes in *Superpower* (2019) that "per person, Australia has natural resources for renewable energy superior to any other developed country."[101] Likewise, the Australian Energy Market Operator (AEMO) has found that a 300% renewable energy target – the generation of three-times Australia's energy needs – could be accomplished through renewable energy generation facilities taking up only 0.15% of Australia's landmass.[102]

Australia's natural endowment of renewable energy capacity is supplemented by a unique abundance of the critical minerals globally demanded as inputs to renewable energy technologies. Lithium is an essential raw ingredient for most battery production. Australia is the world's largest producer of lithium and holds the second-largest reserves of the mineral. Australia also enjoys a leading position in the endowment and production of many other critical minerals and rare earths (summarised in Table 2).

[99] OECD (2020).
[100] Swan (2019).
[101] Garnaut (2019), pp. 8-9.
[102] AEMO (2013).

| Table 2<br>Australia's Endowment of Critical Minerals | | |
|---|---|---|
| | **Global Rank: Established Reserves** | **Global Rank: Production (2021)** |
| **Lithium** | 2 | 1 |
| **Rare Earths** | 6 | 4 |
| **Cobalt** | 2 | 3 |
| **Graphite** | 8 | na |
| **Manganese** | 4 | 3 |
| **Bauxite** | 2 | 1 |
| **Silica** | na | 15 |
| **Vanadium** | 2 | na |
| Source: Adapted from Dept. of Industry, Science and Resources (2022, p. 7). | | |

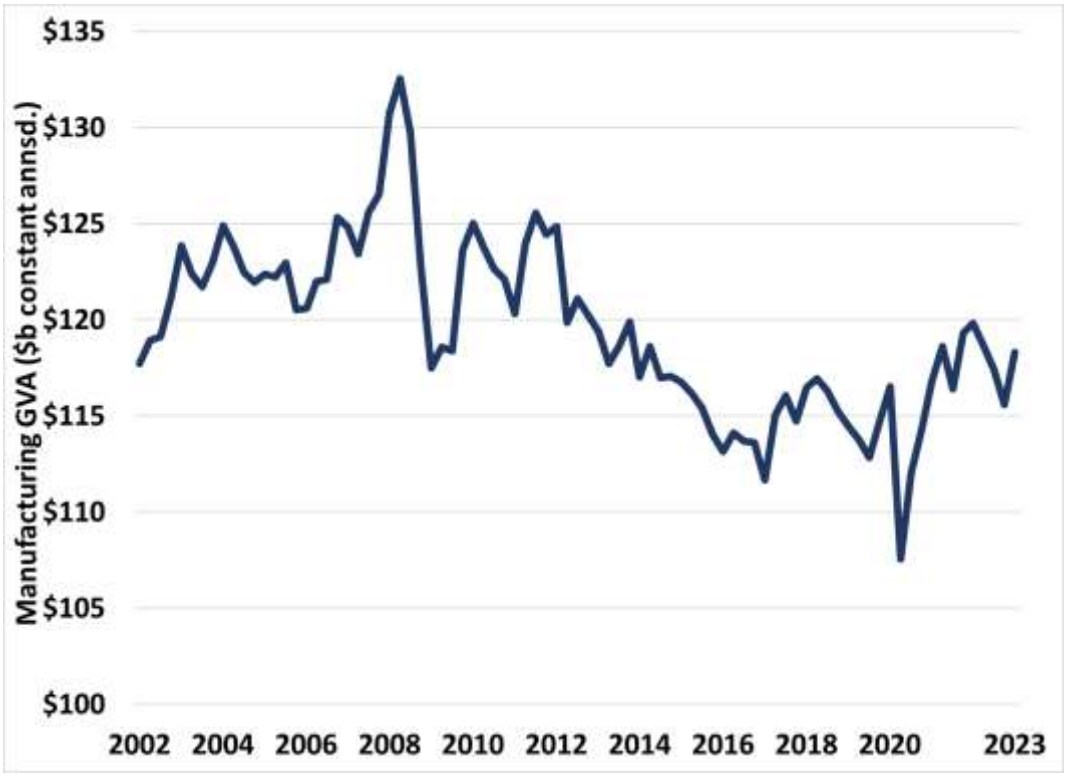
However, is it likely that Australia will be able to convert those resource endowments into a more well-rounded and sustainable form of economic and industrial development? Or will we fall back on our traditional role in the global supply chain, by focusing on extracting and exporting natural resources – in this case, newly-valuable resources associated with renewable energy technologies – and leaving the rest of the technological and industrial work associated with the energy revolution up to others? In that case, Australia would still be left with an unbalanced, underdeveloped economic structure. And it would remain vulnerable to the traditional constraints of resource-led development: including volatility in terms of trade, dependence on foreign investment and foreign markets, and exposure to the environmental side-effects of expansive resource extraction (even resources associated with more sustainable energy technologies).

Already there is growing evidence that Australia is letting the potential benefits of value-added activity associated with the renewable energy revolution slip through its fingers, lacking an effective industrial strategy to make the most of those minerals. While Australia single-handedly supplies over 50% of global lithium production (mostly in the form of crushed unprocessed spodumene), it accounts for less than 1% of the total value-added in the supply chain that converts that lithium into expensive and technology-intensive batteries which in turn are installed in expensive vehicles and other manufactured products.[103]

[103] Toner and Green (2022).

At the same time, there are obvious advantages that Australia's resource base could offer a more diversified and value-added economic strategy. Nahum (2020) argues that Australia's unmatched capacity to generate renewable energy presents profound opportunities for manufacturing: both in the potential to power manufacturing with renewable energy, as well as the opportunity to develop Australian manufacturing capabilities in renewable energy technologies.[104] Dean (2022) argues similarly that Australia possesses a combination of assets (including critical mineral endowments, skilled labour, and industrial assets from previous and continuing domestic automotive manufacturing) that would be fruitful for an active strategy to rebuild domestic mass vehicle manufacturing, coincident with the industry's transformation to electric power technologies. Other domestic manufacturing opportunities associated with renewable energy could include the manufacture of wind turbines and components; specialised transmission equipment; and the reorientation of basic metals production (including steel, aluminium, zinc, and others) around renewable energy supplies.

**Figure 4: Manufacturing Industry in Australia, 2002-2023**




Source: Calculations from ABS Australian National Accounts, Table 6.

However, Australia's potential to seize these opportunities is constrained by the structural underdevelopment of Australia's manufacturing industrial base. Australia's

[104] Nahum (2020).

manufacturing sector has undergone over two decades of contraction and dislocation.[105] Successive governments have largely left the sector to fend for itself in the face of the mining boom of the late 200s and early 2010s, the historic over-appreciation of the Australian currency, unbalanced free-trade agreements, and the disruption brought by the GFC and the COVID-19 pandemic. This led to the unique and concerning contraction of Australia's manufacturing sector in absolute terms after 2008, even as the overall economy continued to grow (see Figure 4). That contraction stabilised after 2017, and then again after the setback of the COVID recession in 2020. But Australia's real manufacturing output remains lower than it was in 2002, even though overall national GDP has expanded by over 70% since then. The legacy of decades of policy inattention to manufacturing is an atrophied industrial base that, without urgent attention, will be unable to capitalise on the new opportunities associated with the renewable energy revolution.

Manufacturing is an industry with important flow-on effects of innovation, economic productivity, and wage growth. As such, this decline has had substantial consequences for Australia's economy. As the global clean technology race picks up speed, any attempt to make Australia a 'renewable energy superpower' must reckon with the country's historically weakened industrial capacity.

# PREVIOUS SUSTAINABLE TECHNOLOGY SUPPORTS

Before the May 2022 federal election, the Commonwealth government provided limited support for domestic clean technology manufacturing initiatives. Nevertheless, there have been several government instruments which have offered financial and regulatory support to clean technology.

Since 2012, the Commonwealth has sponsored two major clean energy technology funding organisations: the **Australian Renewable Energy Agency (ARENA)** and the **Clean Energy Finance Corporation (CEFC)**. These institutions both act to facilitate flows of finance into the clean energy sector, though operating in different stages of technology development and deployment processes, and through different financial mechanisms.[106]

The **Australian Renewable Energy Agency** is the initial financer of clean technology, supporting renewable energy initiatives from research and development stages through to early deployment. ARENA does not purchase equity nor issue loans, instead offering grant funding to promising projects. Through this, ARENA aims to promote

[105] Stanford (2020).
[106] Miller (2018).

renewable energy innovations which can then be expanded to commercial scales, including manufacturing and deployment.[107]

At the stage of technology commercialisation, the **Clean Energy Finance Corporation** becomes relevant. The CEFC is the Australian government's principal green investment fund, often described as a 'green bank'.[108] Its function is to invest in commercial clean energy technology and facilitate greenhouse gas emission reductions across the Australian economy. The CEFC invests in debt or equity in clean energy technology projects, aiming to generate a commercial return. Having been credited with $2 billion A each year for five years following July 2013, the CEFC has invested a total $10 billion A in renewable energy generation, infrastructure, housing, transport, and industry.[109]

As well, in 2020 the federal government launched the **Modern Manufacturing Initiative (MMI)**: a $1.3 billion A funding program, offering grant funding of $1-20 million to domestic manufacturing projects on a matched funding basis. The MMI began in 2020 and will operate for four years until 2024. It aims to invest in six priority areas, one of which is recycling and clean energy.[110] The MMI's program of fiscal support has been greeted with bipartisan support.[111] However, the limited funding pool of the MMI has curtailed the policy's potential to make a significant impact on Australia's nascent clean manufacturing industry.

# NEW CLEAN ENERGY PROGRAMS

Since the election of the Albanese government, several new initiatives have been announced to facilitate significantly greater investment in clean technology development, manufacturing, and deployment. These include the Powering the Regions Fund (PRF), the National Reconstruction Fund (NRF), the Capacity Investment Scheme (CIS), and the Hydrogen Headstart program.

**Powering Australia** is the Australian government's overarching energy and climate change framework, aiming to decarbonise Australia's energy system, meet emissions reduction targets, and make Australia a 'renewable energy superpower'.[112] Forming a key part of Powering Australia is the **Powering the Regions Fund (PRF)**. The PRF is a $1.9 billion A initiative aiming to support the decarbonisation of regional Australia – particularly areas with carbon-intensive economies. It is tasked with supporting the

[107] Ibid

[108] Clean Energy Finance Corporation (2023).

[109] Clean Energy Finance Corporation (2023).

[110] Department of Industry, Science, and Resources (2020).

[111] Daymond (2023).

[112] Australian Government (2023).

decarbonisation of existing industries, the development of new clean energy industries, and facilitating workforce development. Having engaged stakeholders in consultation in late 2022 and early 2023, the PRF is currently in final design stages and is yet to be operational.

Controversially, the PRF is set to utilise carbon credit purchases to help drive regional decarbonisation. The efficacy of driving emissions reductions and offsetting through carbon credits has been widely doubted; some research suggests that carbon credits actually reduce incentives to decarbonise.[113] While there have been public calls for the PRF to abandon carbon credits as a policy mechanism, carbon credit purchasing remains in the PRF's design principles.[114]

The **National Reconstruction Fund (NRF)** is a statutory $15 billion A state investment fund currently being established by the Australian government. The fund, explicitly modelled on the Clean Energy Finance Corporation, seeks to invest in economic areas of priority, namely clean energy, medical science, transport, value-added manufacturing in agriculture, forestry, and fishing, value-added manufacturing in mining, military equipment, and "enabling capabilities".[115] In doing so, the NRF aims to promote economic productivity, secure supply chains, and importantly, "take advantage of opportunities in a net zero economy."[116]

The NRF will operate as an independent financer, promoting private sector co-investment through loans, equity investment, and guarantees. Unlike the similar Modern Manufacturing Initiative, it will operate commercially to deliver a positive rate of return. The Fund will start with $5 billion A, with the remaining $10 billion A to be invested in instalments over the next decade. After 2030, the Fund is expected to generate enough revenue from existing investments to support new projects. An initial $3 billion A of the fund is already designated to be invested directly in renewable and emissions lowering technologies.[117]

The **Capacity Investment Scheme (CIS)** is another new initiative of the Australian government, first announced in December 2022 and funded in the 2023 budget. It aims to facilitate $10 billion A in public and private sector investments in clean energy generation and storage. It will underwrite projects selected through a tender process, seeking to de-risk investment by paying investors if project revenues fall short of a pre-

[113] Armistead, Littleton, and Hemming (2023).
[114] RE-Alliance (2023).
[115] Department of Industry, Science, and Resources (2022a).
[116] Ibid
[117] Department of Industry, Science, and Resources (2022b).

agreed 'floor', though appropriating a share of profits if revenues exceed a pre-agreed 'ceiling'.[118]

The 2023 budget also allocated $2 billion A to the establishment of the **Hydrogen Headstart** program, an initiative to support investment in renewable hydrogen projects. The program aims to support initial renewable hydrogen projects by covering the 'commercial gap' between the current cost of renewable hydrogen and its market value. This intends to facilitate the development of two or three flagship projects to deliver one gigawatt of electrolyser hydrogen capacity by 2030.[119] It is expected to begin funding projects in 2026. Hydrogen Headstart will be designed in collaboration with the Australian Renewable Energy Agency.

Hydrogen Headstart is structured similarly to the production credits offered to would-be hydrogen producers in the United States through the Inflation Reduction Act. However, the Australian policy operates on a much smaller scale, which has been criticised as insufficient.[120] Moreover, the "staggering" amounts of solar and wind power needed to build a significant green hydrogen export industry – approximately 21 times existing capacity – would require government to invest more aggressively in clean energy on a scale far beyond current levels.[121]

## NASCENT INDUSTRIAL PLANNING

In April 2023, the Australian government announced the first **National Electric Vehicle Strategy** to support the increased uptake of electric vehicles (EVs). The strategy pledges to introduce a fuel-efficiency standard for all cars, as well as aiming to improve recycling capacity for EVs and batteries. While the plan was celebrated as an Australian first, critics argue it does not provide substantial policy reforms or targets to accelerate the transition to EVs.[122] It does not commit to any specific support for domestic EV manufacturing, referring instead to the National Reconstruction Fund as a source of fiscal support for transport manufacturing.[123]

Since 2019, the Australian government has formulated a series of **Critical Minerals Strategy** papers to manage Australia's critical minerals industry. The 2023 strategy is intended to outline a plan for the development of a value-added critical minerals industry in Australia, through which raw minerals are processed and developed

[118] Baker Mckenzie (2022).
[119] Department of Climate Change, Energy, the Environment and Water (2023a).
[120] Evans (2023).
[121] BloombergNEF (2023).
[122] Dia (2023).
[123] Department of Climate Change, Energy, the Environment and Water (2023b).

domestically. Critical minerals are essential components of most renewable energy technologies, including solar PV, wind turbines, and batteries. A value-adding critical minerals industry would allow Australia to capture more of the clean technology supply chain, further boosting domestic sustainable manufacturing capability.

A **Future Made in Australia** office has been established in the Department of Finance to co-ordinate government procurement in line with the previously established **Buy Australian Plan**, which directs the Australian government to maximise their procurement from Australian businesses.[124]

The federal government recently announced the creation of a **Net Zero Authority** to oversee the decarbonisation of Australia's economy, particularly managing the transition of significantly affected communities away from carbon intensive economies. The Authority was sparked by an initial proposal from the Australian Council of Trade Unions, and has a particular focus on supporting effective employment transitions as the energy transition advances.[125] The Authority, yet to be established, would coordinate programs and policies across government to help regions, communities, investors, and businesses to take advantage of clean energy industries, and provide transitional supports (including training, relocation, and retirement incentives) for workers affected by the energy transition.[126] A new **Clean Energy Apprentice** program (Australian Apprentices, 2023) will provide federal support for state-based TAFE programs to develop and implement training packages for a future generation of clean energy technicians.

Finally, the Australian government is also currently formulating a **National Battery Strategy**: a sectoral plan for Australia's battery industry. The plan aims to expand Australia's battery manufacturing capacity, capturing part of the growing markets for various types of batteries by embracing the comparative advantages offered by Australia's mineral supplies and educated workforce.[127]

On the whole, these newly-announced programs indicate a genuine concern by government to embrace the accelerating energy transition (rather than attempting to deny or delay it), and a recognition of the multi-faceted policy measures that will be required to position Australian industry well in the rapidly changing technological and global environment. However, as of yet it is clear that the entirety of these responses falls far short of a proportionate Australian response to the game-changing impact of

[124]Department of Finance (2023).

[125] Australian Council of Trade Unions (2022).

[126] Climate Works Centre (2023).

[127] Department of Industry, Science, and Resources (2023).

the U.S. IRA, and equivalent measures being introduced in several other industrial countries.

# INTERNATIONAL CONNECTIONS AND ALLIANCES

As a small open economy, Australia's strategy for the energy transition will necessarily be implemented in the context of international connections and networks, and Australia's federal government has pursued several such initiatives.

Of particular note, on May 20, 2023, at the G7 conference in Japan, Australia and the United States signed a significant agreement concerning bilateral climate co-operation: the **US-Australia Climate, Critical Minerals and Clean Energy Transformation Compact**. The Compact establishes climate action as a central pillar of the US-Australia relatonship. It announces the creation of a new **Clean Energy Industrial Transformation Forum** between the two countries, as well as establishing relevant departmental dialogues.[128]

Beyond this, the agreement signals that the U.S. is intent on closely collaborating with Australia on green industrial development and decarbonisation, principally by linking Australia's Powering Australia plan with the IRA. The Compact emphasises batteries, critical minerals, and green hydrogen as major foci for future technological collaboration. Though dependent on future approval by the US Congress, the Compact proposes that Australia be treated as a domestic US supplier under the IRA, enhancing new investment and export opportunities for Australian critical minerals and clean technology within the broader U.S.-centric supply chain.[129]

The Compact also announced the formation of the **Quad Investors Network**, a collaboration of public and private stakeholders from the Quad states of Japan, India, the United States, and Australia. This network may facilitate international investment and supply chain collaboration between the Quad states, creating further opportunities for Australian supply chain linkages. This could be especially valuable in opening new opportunities for Australian clen technology exports to India, one of the world's largest EV markets.

Australia has engaged with other countries in numerous other initiatives aimed at enhancing cooperation and security of supply around critical minerals supply chains

[128] Prime Minister of Australia (2023).

[129] See Buckley (2023). Australia would likely qualify on this score anyway under the 'friend-shoring' features of the IRA, including the provision that America's free-trade partners will receive access to many of the preferences specified in the new strategy.

and other inputs to renewable energy developments. Some of these bilateral and multilateral initiatives include:[130]

- Australia-US Joint Net Zero Technology Acceleration Partnership.
- Australia-UK Joint Working Group on Critical Minerals.
- India-Australia Critical Minerals Investment Partnership.
- Australia-Republic of Korea Memorandum of Understanding on Cooperation in Critical Mineral Supply Chains.
- Australia-Japan Partnership Concerning Critical Minerals.
- Australia-France Critical Minerals Dialogue.
- Australia-Germany Working Group on Raw Materials.
- Critical Minerals Mapping Initiative with US Geological Survey and the Geological Survey of Canada.
- Minerals Strategic Partnership.
- IEA Critical Minerals Working Party.
- Conference on Critical Materials and Minerals.

Australia's strong international engagement and general political stability are important assets in attracting investments here for the development of critical mineral resources, but also value-added products and technologies based on those resource endowments.

[130] See Department of Industry, Science and Resources (2022, pp. 13-14) for more details.

# 4. Rising to the Challenge

The Australian government is yet to deliver a substantial response to the changed policy environment brought about by the U.S. Inflation Reduction Act. Nevertheless, pressure is growing from businesses, trade unions, environmental advocates, and other stakeholders for the government to develop and implement a more integrated, powerful, and sustained response to the challenge posed by the new climate industrial policies emanating from the U.S. and other industrial countries.

As an initial response to this pressure, the 2022 Australian federal budget allocated $5.6 million A to an internal government task force to catalogue global climate industry policy developments, and then identify actions the Commonwealth government could take in response to catalyse domestic clean energy manufacturing.[131] This project, understood as the first step in developing a full Australian response to the IRA, is set to be completed by the end of 2023.

Significantly, several senior government ministers have publicly flagged their commitment to adequately responding to the IRA and seizing the opportunities of the renewable energy revolution. Treasurer Jim Chalmers has declared it is a priority of the government to make Australia "a beneficiary of [IRA] investments, rather than a victim."[132] Meanwhile, Science and Industry Minister Ed Husic has held discussions in Washington DC exploring the potential to link Australia's National Reconstruction Fund with the IRA, and build a direct value chain between Australian critical minerals mining and US battery manufacturing.[133]

This section of the paper will quantify the scale of the challenge posed to Australian policy-makers by the U.S. IRA and related measures. Then, it will catalogue some of the qualitative best practices that should be incorporated within an equivalent Australian policy framework.

## HOW FAR HAVE THE GOALPOSTS MOVED?

The impact on the economics of renewable energy investments of the incentives and co-investments in the Inflation Reduction Act and related U.S. programs cannot be overestimated. The scale and breadth of the new measures is unprecedented, and are

[131] Commonwealth of Australia (2023), p. 71

[132] Cranston (2023).

[133] Ibid

sparking a revolutionary shift in expectations and decision-making by energy producers, distributers, and manufacturers around the world.

The diversity of policy tools incorporated within the broader IRA framework makes it challenging to attempt to evaluate their total economic impact. Of course, it is not just the fiscal size of the policies that is extraordinary. The willingness of the program to attach those fiscal supports to far-reaching performance requirements and benchmarks – including domestic production, security of supply commitments, and adherence to higher labour standards – will magnify the impact of the new policy framework beyond merely the provision of important fiscal supports and incentives.

Initially the Congressional Budget Office (2022) evaluated the clean energy provisions of the IRA alone at being worth some $383 billion U.S. over its 10-year term (to 2032). This does not include the impact of additional programs also announced by the U.S. to spur the production and use of renewable energy, and the domestic production of manufactured products related to renewable energy. Notable among these are the U.S. Infrastructure Investment and Jobs Act (IIJA), passed in November 2021. That program commits an additional $1.9 trillion U.S. over five years (Parker, 2022). About half of that total is committed to transportation-related applications including manufacturing of electric vehicles, EV charging infrastructure, complementary investments in grid and transmission capacity, railway equipment, and more.

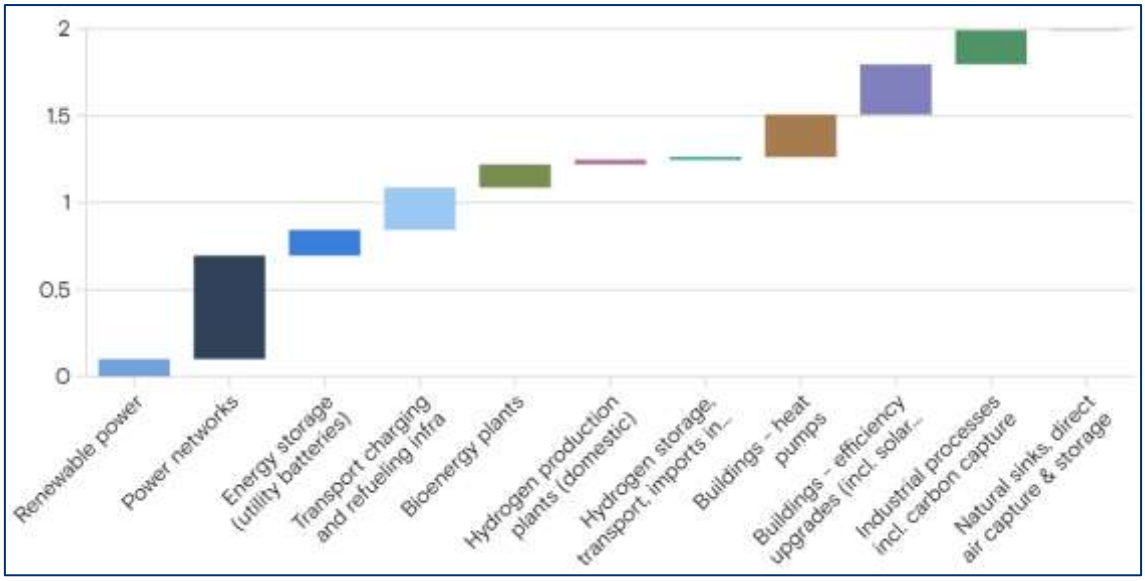
Another feature of the IRA's manufacturing-related provisions is that most of the incentive programs are not capped in dollar terms. Instead, they establish new fiscal and taxation parameters, the value of which will depend on the amount of private sector activity ultimately stimulated. After just the first months of the program's implementation, it is clear that the private-sector take-up of these measures will exceed the cautious assumptions built into the CBO's initial cost assessment – with the result that the resulting scale of effective fiscal support will be much larger. Of course, at the same time, the economic benefits of the program are also expanded commensurately.

> "Roughly two-thirds of the baseline IRA spending is allocated to provisions where the potential federal incentive is uncapped, meaning the ultimate outlay is either based on units of production or upfront capital spent. As such, we believe the Congressional Budget Office is significantly underestimating costs of certain provisions as the attractiveness of credits could propel much higher activity levels, particularly in green manufacturing, carbon capture and clean hydrogen." Jiang et al (2022), p.5

Jiang et al. (2022) estimate that the effective fiscal injection associated with the IRA provisions alone will exceed $800 billion U.S. over the decade to 2032. They project that the stacked benefit of subsidies which apply both to clean energy use and renewable manufacturing activity will make the production and use of renewable energy the cheapest in the world (at less than $5 U.S. per MW/h by 2029). This is eliciting a massive investment response in all stages of the renewable energy supply chain, including manufacturing.

Larsen et al. (2023) project that the production tax credits alone in the IRA will elicit a surge in capital spending totalling $459-552 billion (US) over the next decade. Analysts at Goldman Sachs are even more expansive. They see the expanding impact of the fiscal program as reaching $1.2 trillion (US) over the decade, supporting about $3 trillion in total investment in renewable energy programs over that period across the full range of the supply chain (as illustrated in Figure 5).

**Figure 5. Investment Opportunity Across US Energy System by 2032 ($ trillion US)**




Source: Goldman Sachs Research (2023).

There are many policy challenges facing Australia in the wake of this dramatic U.S policy shift. Australia's goal clearly should not be to simply mimic the U.S. measures: Australia possesses significant advantages in some areas (such as critical minerals and renewable energy supply) that should be leveraged and amplified, while at the same time facing structural challenges and barriers (including a small domestic market, geographic isolation, and an underdeveloped starting manufacturing capacity) that will need to be overcome. Australia needs nothing less than a multi-dimensional strategy to nurture not just renewable energy production and use, but the full range of value-added activity related to the energy transition. In our judgment, if anything Australia

will likely need stronger policy leadership than the U.S., to achieve a similarly transformational impact on domestic energy production and use, and domestic manufacturing and technological capabilities.

As an initial step, it is critical for policy-makers to appreciate the order of magnitude of domestic fiscal intervention that will be required just to match the U.S. effort, let alone address the structural disadvantages that have (so far) held back Australia's full-fledged participation in this industrial transformation. Based on the wide range of projections of the likely ultimate value of the incentives and supports contained in the IRA and related programs (including the IIJA), we have developed an estimate of the proportional scale of fiscal supports that would be required in Australia. We bracket the various estimates of the value of U.S. fiscal supports with a low case ($750 billion U.S. over ten years) and a high case ($1.25 trillion), as summarised in Table 3.

**Table 3**
**Proportionate Scale of IRA and Related Funding**

| | Low Estimate | High Estimate |
|---|---|---|
| **Ten-Year Cost of IRA & Related Programs ($US b)** | $750 | $1250 |
| **Exchange Rate (OECD PPP)** | 1.419 | |
| **Australian Population Share (%)** | 7.8% | |
| **Equivalent Scale ($Aus b)** | $82.6 | $137.7 |
| **Annual Cost ($Aus b)** | $8.3 | $13.8 |

Source: Calculations from sources cited in text.

Applying a purchasing power parity exchange rate (as reported by the OECD) and scaling the fiscal impact in proportional per-capita terms, this suggests a necessary scale of Australian fiscal support for development and production of renewable energy systems (including manufactured components and spin-offs). The low estimate of IRA and related funding (consistent with Larsen et al., 2023, including IIJA commitments) suggests Australian commitments of $83 billion (Aus.) over the coming decade. The higher estimate (consistent with the Goldman Sachs projections) implies Australian commitments of $138 billion over the same period. The Jiang et al. (2022) projection falls in the middle of this range, once related supports (including IIJA measures) are included. It should be noted that this does not include the direct capital cost of investments in new renewable energy projects (including solar, onshore and offshore wind, geothermal, and related transmission investments), which will account for a

much larger cumulative injection of investment as Australia's power system is transformed.

The clear message from this analysis is that Australia must be prepared to "go big" in its intervention in climate industrial policy, if it hopes to build a healthy and proportionate share of the technology-intensive value chain associated with the renewable energy transition.

# PRINCIPLES AND BEST PRACTICES TO SEIZE SUCCESS

The preceding discussion confirms that Australia must respond to the new era of pro-active climate industrial policy with a forceful and well-resourced strategy, backed by significant fiscal resources. However, given the unique set of attributes and challenges confronted by Australia in entering this new global competition, the policy goal cannot be merely to imitate the U.S. provisions that have so altered the global competitive terrain in renewable energy and related manufacturing. Instead, Australia's response needs to be tailoured to its industrial and environmental starting point. To that end, we propose several best practices which Australian policy-makers should consider closely as they assemble policies that not only match the U.S. climate industrial policy in force and ambition, but also target and shape that response to reflect the reality of Australia's starting point.

**Coordination and Planning**

A successful climate industrial strategy will have many moving parts: involving actions and interventions from various levels of government, private investment decisions, and participation by other stakeholders. This highlights the overarching need for effective planning and coordination in the development and management of these policies. Spurring the massive investments and innovation that will be needed at all points in the renewable energy supply chain – from generation to transmission to consumption, and engaging manufactured inputs every step of the way – requires simultaneous progress to be made on all fronts. Governments at all levels need to plan pro-actively and cooperatively to identify key opportunities and barriers to the overall strategy, target interventions where they can have the most impact, and react quickly to emerging challenges and changes. Interventions must be coordinated with other sector stakeholders for maximum impact on investment and growth. The nascent industrial planning capacities being considered as part of current renewable energy strategies (reviewed above) need to be provided with genuine authority and resources to steer the development of the overall strategy. Private businesses can be engaged in

this planning process, as well: even when they compete with each other, individual private firms benefit when the whole strategy succeeds.

**Sovereign Capability in Key Functions**

Given Australia's relatively small population and presently underdeveloped manufacturing capacities, it would be folly to expect the country to be able to supply all features and inputs required in an all-round climate industrial strategy. So it is inevitable that Australia will continue to rely on imported inputs and technologies to support the roll-out of domestic renewable energy developments, and their manufacturing spin-offs. However, it is vital for several reasons that Australia achieve the capability to produce some essential systems and components that will play central roles in the energy transition. Geopolitical and security-of-supply concerns dictate the pro-active development of domestic capability of key components and technologies. This concern is well understood regarding the supply of the original critical mineral inputs that are now a key priority in international economic and security planning. Australia's abundant endowments of these resources, and our preferential and trusted trading relationship with the U.S. and other allies, gives us an advantage in this dimension. But the same logic applies to various manufactured components that are equally vital to the success of renewable energy developments – including batteries of all sizes, key renewable energy generation equipment (such as solar cells and wind turbines), specialised transmission technology, and even final assembly of key sustainable energy-based products (like EVs). Just as was discovered during the COVID pandemic regarding the essential importance of domestic capability to produce essential health and medicinal products, a country that is unable to meet at least some of its own needs will remain vulnerable to disruptions in global supply chains caused by any number of reasons. Moreover, if Australia does not possess the capacity to compete for at least a share of these rapidly expanding global markets, then the economic and technological benefits associated with those products will pass us by. For these reasons, targeting national capability in the manufacture of key elements of evolving renewable energy systems (including battery components, batteries, and vehicles) should be a priority in the design of overall climate industrial strategies.

**Performance Requirements and Monitoring of Private Subsidies**

Extensive fiscal supports for private investment and production will be essential to the quick ramp-up of sustainable manufacturing as the energy transition gathers speed – although public equity and co-investments should play a key role, as well (as discussed below). For maximum effect, however, public incentives and subsidies to private firms must be tied directly to clear and enforceable performance requirements, and feature

strong reporting, accountability, and if necessary claw-back provisions in order to ensure that public resources are utilised for their designated purposes. The refundable production tax credit model that features prominently in the U.S. IRA strategy has a natural built-in performance requirement, in that the subsidy is not paid unless the production actually occurs. Even in this case, though, it is essential that government establish transparent reporting and accountability mechanisms to ensure that production thresholds are met. A similar need exists for reporting and enforcement provisions related to additional standards and benchmarks established for publicly-supported business projects, including labour standards and environmental requirements.

**Public Equity and Accountability**

A major focus in the IRA and complementary strategies is to enhance the bottom-line incentive for private firms to invest in various aspects of renewable energy expansion, including related manufacturing activities. This is appropriate, given the critical role played by private firms, with proprietary technology, in numerous stages of the renewable energy supply chain. However, the public sector's engagement in this industrial strategy should not be limited to simply subsidizing private ventures. Public institutions make critical contributions to the innovation effort required to fulfil the promise of renewable energy, and those contributions should be recognised and rewarded.[134] The public sector should have the opportunity to share in the upside of successful subsidised ventures – not just bear the cost of unsuccessful ones. And in several segments of the overall energy transition, it is most appropriate for the public sector to take a central equity role in owning, planning, and ultimately profiting from the roll-out of renewable energy systems and technologies. This is especially the case in infrastructure assets and systems (like electricity generation and distribution), in which the provision of essential services is best conducted through public corporations with a mission to service the community at low cost and high reliability – in contrast to the waste and unreliability which has accompanied fragmented, rent-seeking privatised utilities.[135] A bigger role for public equity stakes in various stages of renewable energy systems (potentially including public equity participation in strategic manufacturing undertakings, as well as traditional forms of public ownership in utilities and resources) would constitute a key difference between an Australian climate

[134] Mazzucato (2013) catalogues the critical contributions made by public research and innovation capacity to successful technological and industrial developments throughout the postwar era, and the importance of reflecting those public contributions with stronger public equity participation in the ownership and returns from those developments.

[135] For more on the core economic inefficiency and dubious impacts on consumer welfare of Australia's privatised electric utilities, see Richardson (2019).

industrial strategy and the U.S. vision (which focuses primarily on incentivising private investment throughout the renewable energy supply chain).

**Investment in a Skilled, Inclusive Workforce**

An ambitious program to support both renewable energy developments, and the manufacturing spin-offs associated with those investments, will spur the creation of tens of thousands of new jobs in coming years. Many of those jobs will be located in direct energy generation and transmission functions. But many others will be associated with the manufacture of inputs to renewable energy projects, and downstream manufacturing activities which utilise clean energy as a competitive, sustainable input. There is no doubt that the scale of this job creation will outweigh the gradual, and hopefully well-supported, phase-out of work in fossil fuel activities (Stanford, 2020b); the energy transition will clearly have a net-positive impact on overall employment. However, a potential constraint on the expansion of renewable energy and related jobs is posed by the need for training and skills acquisition among recruited workers. Chau et al. (2023) project a need to train over 160,000 new workers in renewable energy-related occupations by 2050. And this is on top of existing skills and vocational education challenges facing conventional manufacturing (as catalogued by Carney and Stanford, 2018). Such an ambitious skills and training agenda will require a focused and well-resourced plan, supported by Commonwealth and state governments, industry, and trade unions. The Commonwealth government has announced a new clean energy apprenticeship program to start to develop a pipeline of future trained workers for this sector (Australian Apprentices, 2023), but much more will be required to ensure that skills shortages do not constrain the ability of Australian industry (including manufacturers) to capitalise on the coming opportunities. Revitalising and fully engaging the training capacities of TAFE institutes, which offer the most reliable and consistent vocational training programs, will be especially important in realising these goals.

**Strong Labour Standards**

The Biden administration has creatively and ambitiously linked its industrial policy interventions to parallel efforts to address long-standing inequities in U.S. labour policy and industrial relations. The U.S. policy framework links fiscal incentives for production to commitments around prevailing wage policy, voluntary recognition of trade unions, pay equity and hiring from disadvantaged communities, and other equality-seeking labour goals. This linkage reflects a desire by the government to ensure the benefits of climate industrial policy are shared broadly across America’s deep socio-economic divides. It also represents an effort by the Biden administration to evade the blocks to progress on traditional labour policy levers (like the minimum wage and collective

bargaining regulations) that have erected by Republicans in Congress. Australia's industrial relations framework is very different than that of the U.S., so no simple replication of these policies would be appropriate. But the general principle that governments should attach strong labour standard conditions to the fiscal supports offered to private business is entirely valid in Australia, too.[136] Prospective policy levers that should be attached to Australian fiscal incentives should include restrictions on the use of casual, outsourced, or labour hire employment practices by subsidised firms; payment of prevailing wages[137]; and participation in regular negotiations with relevant unions on collective bargaining, skills and training, and related topics.[138]

**Multi-Stakeholder Model of Policy Development and Implementation**

The general goal of industrial policy is to enhance the presence and viability of desirable technology-intensive, export-oriented economic sectors above and beyond what would be forthcoming from the private cost-benefit decisions of private businesses. The rationale for these interventions is that the social cost-benefit calculus of these investments differs from the private cost-benefit calculations made by individual firms, hence justifying a public role in stimulating additional activity and addressing underinvestment that comes from private decisions alone. It is commensurate with this vision, therefore, that the design, implementation and monitoring of new climate industrial policies benefit from the input and participation of all stakeholders with an interest in this historic transition. This includes the companies participating in renewable energy developments and related manufacturing activity. But it must also include other stakeholders as full, empowered partners in the design and implementation of these policies: including governments at all levels (including regional and community councils), trade unions, higher education institutes (particularly including TAFE institutes), Indigenous community councils and leaders, research and engineering bodies, and more. A multi-stakeholder approach can improve the extent to which the overall impact of the strategy maximises the all-round economic, social, and environmental benefits arising from this transition. Ensuring strong regional and community participation in planning renewable energy projects and related initiatives can also be crucial in managing the local impacts (on infrastructure, land use, and local economic capacities) of major renewable energy

[136] For more examples of how progressive labour and social conditions can be attached to government fiscal policies and procurement strategies, see Stanford (2018).

[137] These provisions could be similar in spirit to the U.S. Davis-Bacon rules providing payment of prevailing wages on federally-constructed construction work; see U.S. Department of Labour (2022) for a summary.

[138] The Electrical Trades Union has proposed new structures of multi-employer bargaining to establish common standards and facilitate job mobility within the growing solar energy installation and maintenance sector; see Thompson (2022).

projects. Multi-stakeholder bodies and tables could be constituted to guide and evaluate industrial policy progress in specific sub-sectors of the transition (such as the Zero Emissions Vehicles National Innovation Council, or ZEVNIC, proposed by the Australian Manufacturing Workers Union, 2022), or for specific states or regions.

**Place-Based Industrial Policy Considerations**

Geography is a critical dimension of industrial policy making in a large country like Australia. The overarching strategy must be sensitive to the unevenness of distribution across Australia of assets with value for renewable energy manufacturing developments (including both renewable energy assets and legacy industrial assets and capacities). It must also pay due attention to the importance of addressing particular socio-economic challenges in regions of the country which are potentially more exposed to transition challenges as the energy revolution accelerates. This would include areas with traditional concentrations of fossil fuel production and use (such as the Hunter, Latrobe, and central Queensland regions),[139] as well as areas that experienced the most acute employment disruptions during the previous era of deindustrialisation (such as outer suburbs of Adelaide and Melbourne, Geelong, and Newcastle). Designing the new climate industrial policy framework to consciously direct particular opportunities to these regions will help to cement broader buy-in to the program across different geographic and socio-economic segments of society, and ensure that the energy transition offers economic hope and opportunity to those who have been denied it in recent decades. This deliberate geographical targeting of fiscal and industrial interventions has been a prominent feature of the U.S. IRA and related policies, as noted by Muro (2023):

> "Place-based strategies… may be able to engage more directly and efficiently with the roots of problems and the needs of individuals and firms in local communities. In that fashion, the new policies seek to boost the national economy by investing to help local economies, whether by supporting regional innovation clusters or financing creative workforce partnerships." (Muro, 2023)

[139] Stanford (2020) catalogues 11 communities, ot of 350 Australian communities defined at the SA3 level of aggregation, where direct fossil fuel employment accounts for over 5% of total regional employment, and hence which can be considered particularly exposed to the transition away from fossil fuel use. The small number of such communities suggests that deliberately targeting industrial policy supports related to the energy transition could be a powerful measure in supporting the corresponding employment transitions.

Place-based policies could play an equally powerful economic and political role in consolidating widespread participation in, and political support for, an ambitious climate industrial strategy for Australia.

**Sustainable Production Practices**

The overarching goal of the energy transition is to address concerns over accelerating climate change and other environmental side-effects of fossil fuel production; this has been supplemented, more recently, by an effort to take advantage of the cost advantages of renewable energy, now that they have become less expensive and more reliable than conventional energy forms. However, it is important for both economic and environmental reasons to ensure that renewable energy and related undertakings must themselves be managed to minimise the environmental side-effects of production at all stages of its supply chain. Environmental consequences from unplanned expansion of critical minerals extraction are attracting legitimate concern (see, for example, Barrett, 2023). And while the expansion of market penetration of EVs holds great potential to reduce future greenhouse emissions from vehicle transportation, emissions expended during production of vehicles and their components themselves constitute a significant source of climate-changing pollution.[140] A core priority for climate industrial policy, therefore, must be strong requirements for commitments to environmental best practices at all stages of the renewable energy value chain: including mining, processing, and manufacturing. These include strong land-use, protection, and reclamation standards for critical minerals extraction and processing facilities; ambitious timelines for full phase-in of renewable power for energy use by miners, processors, and manufacturers; and strong systems for end-of-life recycling of batteries and other components.

# FISCAL DIMENSIONS OF CLIMATE INDUSTRIAL POLICY

The preceding analysis suggests that Australia must be prepared to commit unprecedented resources, policy leadership, and multi-stakeholder engagement to implementing a plan to capture a healthy share of the vital industrial benefits that will be generated by the worldwide energy transition. In fiscal terms, aggregate levels of support equivalent to $100 billion A or more over the next decade will be required just to match the proportionate scale of U.S. IRA and related interventions – let alone to

[140] Estimates suggest that half of the life-cycle greenhouse gas emissions associated with EVs occur during the production phase, most importantly emissions during the mining and refining of critical minerals inputs to batteries; see Toner and Green (2022).

overcome some of the even more constraining structural disadvantages that Australia presently faces in the global race for renewable energy manufacturing opportunities. This is an ambitious and expensive undertaking by any measure, and some observers will invoke this price tag as another reason for Australia not to even try to carve out manufacturing capabilities in the renewable energy transition. Instead, it will be argued, the country should satisfy itself with fulfilling its 'natural comparative advantage' role in the global energy transformation: namely, resource extraction and export. That role would inevitably consign Australia to supplying a new generation of non-renewable mineral resources to other countries, which then undertake the more lucrative task of adding value to those resources by transforming them into (much more expensive) end products.

Concerns over the fiscal scale of climate industrial policy interventions must be considered in the context of several key considerations. Firstly, the long-run costs of not accelerating our domestic renewable energy capacities (including manufacturing activities tied to renewable energy) will be immense. There is no doubt that the global economy is quickly transitioning away from conventional fossil fuel-based energy technologies, for competitive as well as environmental reasons. Australia's traditional focus on fossil fuel extraction and export industries poses a major vulnerability, unless those industries are replaced by other energy and manufacturing activities with a brighter long-term future. Failing to position Australia well within that inevitable transition will impose massive economic, social and fiscal costs in future years. Similarly, the fiscal costs to government of the withering away of Australia's fossil fuel export industries, if they are not replaced by other industries with strong technology, employment, and environmental characteristics, will be much larger than the costs of investing in accelerating Australia's renewable energy capacities today.

Secondly, with careful design, climate industrial policy interventions can be tied directly to the stimulus of incremental investment, output, and employment that in turn generate fiscal flows that offset much of the cost of the initial incentives.[141] This is obvious in the case of production tax credits, which feature prominently in U.S. and other national climate industrial strategies: if the production does not occur (with resulting employment, income, and fiscal benefits), then the incentives are not paid. Even with other less direct policy interventions, proper performance requirements and monitoring and enforcement levers can ensure that resulting economic gains are achieved – again, with benefits to the fiscal bottom line of governments.

[141] Congressional Budget Office analysis suggests the U.S. IRA, despite its massive cost, will net reduce the U.S. federal deficit by some $238 billion U.S. over ten years, in part thanks to offsetting revenue measures also contained in the overall package (see Committee for a Responsible Federal Budget, 2022).

Finally, the cost of climate industrial policy measures must be evaluated against the opportunity cost of other government fiscal commitments, which in many cases carry less important or in some cases counter-productive environmental, economic, and social implications. Table 4 summarises several current major fiscal commitments currently supported by the Commonwealth government. Every one of them implies a scale of ongoing fiscal support equal to or greater than the estimated cost of an IRA-matching climate industrial strategy (as outlined in Table 3 above). It is impossible to sustain the argument that Australia cannot afford to proportionately match U.S. efforts to stimulate new renewable manufacturing, when much larger flows of fiscal resources are being directed to such questionable priorities.

**Table 4**
**Alternative Fiscal Priorities**

| Priority | Cumulative Cost and Term ($b) | Annual Cost ($b) |
|---|---|---|
| Climate industrial policies to match scale of U.S. IRA and related programs | $83-$138 (10 yrs) | $8.3 - $13.8 |
| Purchase and maintenance of nuclear-powered submarines under AUKUS treaty | $268-$368 (30 yrs) | $8.9-$12.3 |
| Stage 3 tax cuts | $243 (10 yrs) | $24.3 |
| Existing subsidies for fossil fuel production and use | Ongoing | $11.1 |

Source: Table 3 above; Greene and Doran (2023); Littleton (2022); Campbell et al. (2023).

# CONCLUSION: A CALL TO ACTION

The orthodox 'comparative advantage' economic theories that have dominated Australia's trade and industrial policies in recent decades have left a worrisome legacy. Australia's international trade is more dependent on the extraction and export of largely unprocessed natural resources than at any time in the postwar era. The fossil fuels which make up a large and growing share of those mineral resources have a definite 'best-before' date, that is approaching quickly. Australia's capacity to innovate and diversify in the face of that structural challenge has been eroded by decades of uncreative willingness to serve as the world's quarry. Even as the renewable energy revolution reshapes global demand for minerals, focusing attention on critical minerals in which Australia, fortunately enough, also enjoys large endowments, a failure to pro-actively carve out a more diversified value-adding role in these new global industries is

reinforcing our underdeveloped position in world trade. We may be extracting and exporting a new set of non-renewable minerals, that other countries transform into value-added products which we purchase back from them. But we are ultimately fulfilling the same dependent role in global value chains as we did with the previous portfolio of minerals.

The renewable energy transformation opens a generational opportunity for Australia to reimagine its stunted role in the global economy. Because entire industries (like electricity generation and vehicular transportation) are being reinvented from the bottom up, new players can hope to join that new global competition. To take just one example, Australia squandered most of its once-significant role in global automotive manufacturing thanks to misplaced confidence that our resource abundance meant we didn't need to worry about industrial policy. Now, as internal combustion technologies are quickly supplanted by EVs and other sustainable technologies, openings are arising for new businesses and new producing regions to participate in an entirely new automotive industry. Australia has many assets which could support a successful entry to that industry. But it will only occur with a forceful, focused effort to deliberately build that industry: reliance on global market forces, the decisions of private firms, and supposedly attractive foundational policies (like stable macroeconomic conditions or competitive taxes) will not do that, only reinforcing Australia's underdeveloped role in global trade and investment.

Renewable energy developments offer enormous potential for stimulating a wide range of economic as well as environmental benefits. The new work, investment, and technology associated with sustainable energy projects could provide a substantial boost to the domestic economy as it transitions away from reliance on fossil energy sources. The additional opportunities associated with manufacturing inputs to those projects, as well as using renewable energy to power a new generation of sustainable manufacturing, only enhance the appeal of making the most of the energy transition.

The foundations of orthodox trade and industrial policy frameworks were already shaky, after the experience of China's rapid industrialisation, the Global Financial Crisis, and the COVID pandemic. The assertive, transformative features of the Biden Administration's Inflation Reduction Act, supplemented by other similarly powerful interventions, have put the final nails in the coffin of *laissez faire*, comparative advantage policy-making. Other jurisdictions, from the EU to Canada to Korea to even Saudi Arabia, are following the U.S. example with equally ambitious, well-funded climate industrial strategies.

Australia has the fiscal, technological, and human resources potential to do likewise. If we seize this moment and make a national commitment to converting our unmatched

renewable energy and critical minerals resources into a fully-fledged, diversified, and sustainable economy, we will lay the foundation for an entirely new and exciting chapter in Australia's economic history.

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