Australian Government

Industry Sector Plan

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Acknowledgement of Country

We acknowledge the Traditional Owners of Country throughout Australia and recognise their continuing connection to land, waters and culture. We pay our respects to their Elders past and present.

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Ministerial foreword

As the world economy decarbonises, the Albanese Labor Government is focused on backing a revitalised manufacturing sector in a more productive, more resilient, and more diversified Australian economy, consistent with a Future Made in Australia.

Australia has all the critical and strategic mineral resources that the future global industrial economy requires, vast wind and solar resources, the advantages of our geography and a skilled and resilient workforce. The challenges of a changing geostrategic landscape and the global shift to lower emissions require an ambitious plan to back Australian industry.

The Industry Sector Plan sets a path to net zero emissions for Australia's industrial and waste sectors in a way that leverages Australia's advantages, recognises the challenges, and drives international competitiveness.

Some parts of existing industry will reduce emissions by using less carbon-intensive energy sources. For some sectors electrification will be key, allowing them to take advantage of cheap electricity from wind and solar backed by batteries. Hard-to-abate sectors, like those requiring high heat or chemicals manufacturing firms, will continue to use natural gas where production processes require. For some of these sectors a move to green hydrogen, when it is affordable, will be possible. Investments to improve energy efficiency and change production processes will also drive emissions down. There is also significant opportunity to kickstart new industries like green iron, which take advantage of Australia's resources and energy endowments.

A decade of underinvestment in the energy grid has left Australia's industrial sector vulnerable. Despite being a leading global exporter of LNG, Australia's energy system, and in turn industry, is exposed to international gas price shocks. A lack of energy policy certainty through 22 discarded energy policies prior to 2022 has seen corporate underinvestment in new and emerging technologies, including renewable energy infrastructure and new production processes. While it is an imperative to reduce carbon emissions to ensure we mitigate the worst impacts of climate change, it does not mean the pathway will be linear or without challenges.

This plan recognises the significant challenges Australian industry faces and will continue to face as it decarbonises. For some sectors, abatement technology either does not exist or is too expensive, and all industry is dealing with pressures on the cost of energy. Effective policy and joint effort between governments, industry and unions will be vital to ensuring we meet these challenges in the national interest.

The government is undertaking major structural reform to address the energy market pressures. The Gas Market Review, led by Minister Bowen and Minister King, which builds on the Future Gas Strategy, is examining long-term policy settings for Australia's gas markets to drive affordable and secure gas and investment. The National Electricity Market wholesale market settings review, led by Minister Bowen, will unlock long term investment in Australia's national energy grid to ensure affordability and reliability. Minister Watt has committed to reforming environmental approvals, which will help renewable generation and transmission projects get built sooner, while protecting Australia's unique and invaluable environment.

In tandem, the Albanese Labor Government is making the most significant pro-manufacturing investment in Australian industry in the nation's history. This includes the Net Zero Fund, a new $5 billion sub-fund of the National Reconstruction Fund (NRF), that will draw from and refocus existing NRF capital. It will support major investments by large industrial facilities in decarbonisation and energy efficiency, and scale up manufacturing low emissions technologies. The remaining $10 billion of the NRF's capital will continue to drive investment in Australian firms to diversify and transform the nation's industrial base. In addition, the $22.7 billion Future Made in Australia agenda is further supported by the $1 billion in the new Green Iron Investment Fund to help Whyalla and other local manufacturers make iron using low or zero emissions energy.

In a changing global environment, we have the collective responsibility to ensure Australian industry remains competitive and is a critical contributor to Australia's economic future. A vibrant industrial and manufacturing sector is critical to creating and protecting good jobs in our regions and outer suburbs. The Albanese Labor Government is seized of this opportunity – backing Australian industry as a critical contributor to communities, workers, our economy and sense of national pride.

The Hon Tim Ayres
Minister for Industry and Science

The Hon Chris Bowen
Minister for Climate Change and Energy

Executive summary

As part of the Paris Agreement, Australia has legislated climate action goals in the *Climate Change Act* 2022, committing Australia to achieve net zero emissions by 2050. The Industry Sector Plan sets out pathways for the Australian industrial and waste sectors to meaningfully reduce direct greenhouse emissions and help businesses transition to net zero.

Australia's industrial sector is vital to the nation's economic strength and resilience. It now faces a pivotal transformation amid the global push towards net zero emissions. Traditionally reliant on fossil fuels, the sector must adapt to remain competitive. The transition away from fossil fuel use will be complex, requiring industries and government to work together to navigate evolving energy systems, competition for technology and changing markets. Adapting to address these challenges is fundamentally in Australia's economic interest, bringing new growth opportunities and supporting competitiveness in a decarbonising global economy. Decarbonising industry is also necessary to meet domestic climate commitments of 62–70% emissions reductions below 2005 levels by 2035 and net zero by 2050.

Securing and strengthening our existing industrial capability and seizing emerging opportunities in the clean economy will be vital to our Future Made in Australia. Capitalising on our advantages will revitalise our industrial base and ensure Australia remains globally competitive, while contributing meaningfully to the national net zero target. Australia has what is necessary to make this transition: abundant minerals and renewable energy resources, infrastructure, an experienced workforce and a world class research and innovation sector.

The Industry Sector Plan provides an overview of the pathway for how Australia's industry and waste sectors will contribute to meeting the 2030, 2035 and 2050 emissions targets. We created the plan using targeted and ongoing stakeholder engagement, which gave us important insights on opportunities for technology development.

The Industry Sector Plan has 3 principles:

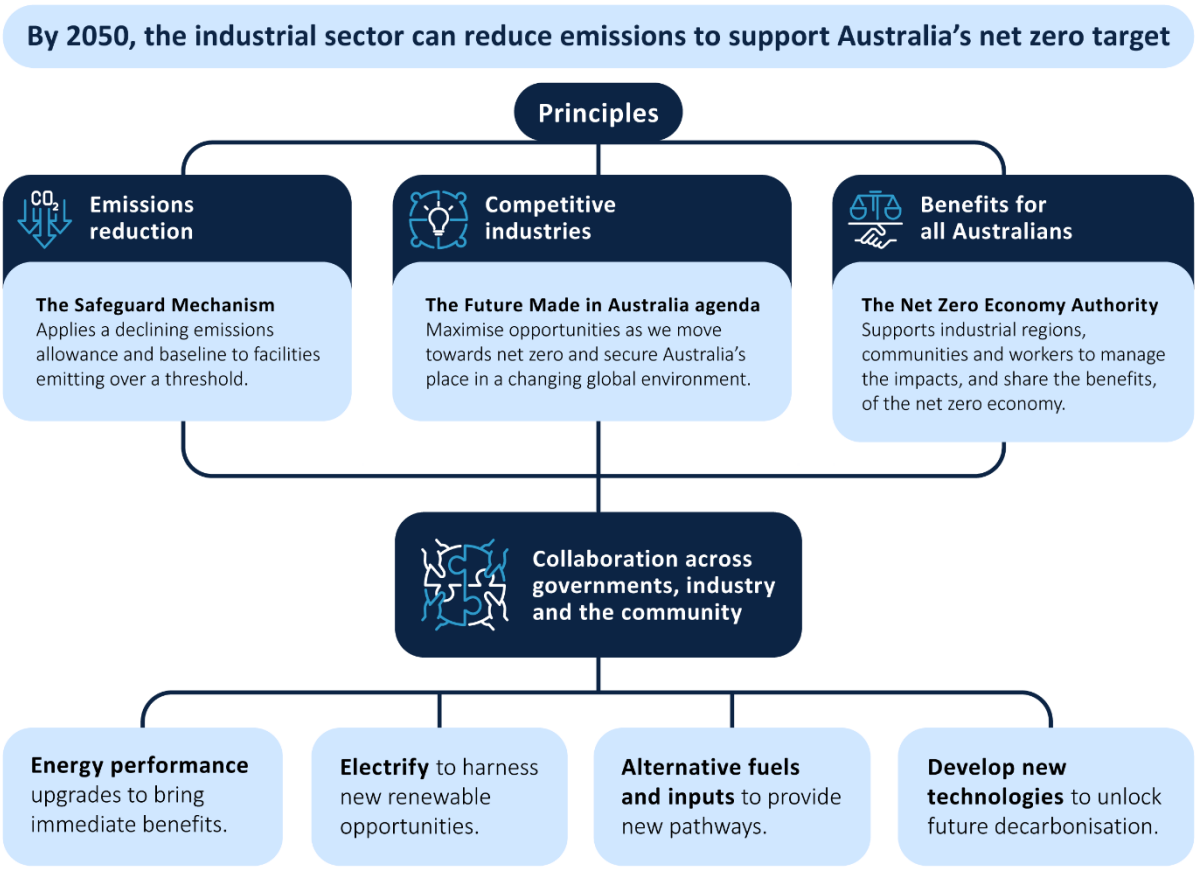
- meaningfully reduce emissions
- maintain and grow competitive industries
- deliver a just and equitable transition.

These principles lean on existing measures including the Safeguard Mechanism, the Future Made in Australia agenda and the Net Zero Economy Authority.

The Industry Sector Plan sets out a clear pathway towards net zero for industries. Optimising energy use through energy efficiency and demand flexibility upgrades will immediately help reduce industrial emissions. Electrifying many industrial processes is a critical next step, allowing businesses to reduce emissions by using renewable electricity. For processes that are unable to electrify now, scaled-up alternative fuels and inputs like hydrogen and bioresources will become available. Finally, coordinated efforts from Australia's world leading researchers, innovators, businesses and government will work to bridge technology gaps in sectors that rely on hard -to -abate, high -heat processes. Natural gas usage may still be required for sectors where no other alternatives exist, though abatement is possible through carbon management technologies.

The Australian Government acknowledges industry transition will take time and will need to align with the rollout of renewables and technology development. Heavy industries face compounding challenges that require coordinated efforts from governments and businesses to solve. Many of Australia's manufacturing and heavy industry hubs are also foundational parts of local economies and communities. We need to carefully consider the social and regional aspects of the industrial net zero transition to ensure it is both equitable and effective. Community engagement and investment in regional workforces, including retraining and education, will win social license for decarbonising Australian industry. Delivering tangible benefits to Australian industry from decarbonisation will also increase community support.

Successfully decarbonising Australia's industry and waste sectors will significantly benefit the nation, if we can coordinate, manage and balance the process's ambition and feasibility. This Industry Sector Plan shows how public, private and community stakeholders can work together to reach net zero.



To 2030 Deploy existing opportunities and planning	• Safeguard Mechanism to drive abatement for large industrial emitters. • Accelerate deployment of commercial abatement technologies and grow industry knowledge and awareness to build momentum • Plan and begin action on the key enablers required for net zero
To 2035 Widespread adoption of existing technologies and commercialise new technologies	• Widespread deployment of commercially available net zero technologies such as energy performance upgrades and electrification. • Heavy industries expected to deploy technologies at scale, enabled by the buildout of the renewable grid and driven by the Safeguard Mechanism. • Trials and commercialisation of new technologies, and the scale up of enablers and alternative inputs such as hydrogen and alternative fuels to progress at pace
To 2050 Net zero and new market opportunities	• Significant emissions abatement from across all industry supported by the successful delivery of key enablers and technology developments. • Growth of new industry opportunities in green metals, green chemicals, clean energy manufacturing and other areas of comparative advantage. • Safeguard Mechanism drives abatement to net zero which may include use of carbon management technologies for residual industrial emissions.

Figure 1: Industry Sector Plan overview

Introduction

Australia's industrial sector is more than just a producer of goods – it is a foundation for national economic health, international competitiveness and long-term sustainability. Its growth supports jobs, drives exports and underpins infrastructure, making it essential to Australia's prosperity. The world is undergoing the biggest and fastest economic transformation since the industrial revolution. Australia must use its strengths to develop competitive, diverse, higher -value industrial businesses.

The Industry Sector Plan covers 9 subsectors that represent Australia's manufacturing and waste sectors:

- alumina and aluminium manufacturing
- waste and resource recovery
- iron and steel manufacturing
- chemicals and plastics manufacturing
- cement and concrete production
- food and beverages manufacturing
- manufacturing and additional industries
- pulp, paper and paperboard manufacturing
- other metals refining and smelting.

Appendix B contains overviews of each subsector.

This plan highlights areas of greatest opportunity and need for decarbonisation. It also discusses those that the economy's transition to net zero will affect the most.

The plan primarily focuses on the decarbonisation of scope 1 (direct) emissions from industrial and waste sectors. Figure 2 shows the 9 industrial subsectors' scope 1 emissions.

In 2024, the 9 industrial subsectors contributed 62 million tonnes of CO_2-equivalent emissions, or **14% of Australia's net emissions.**

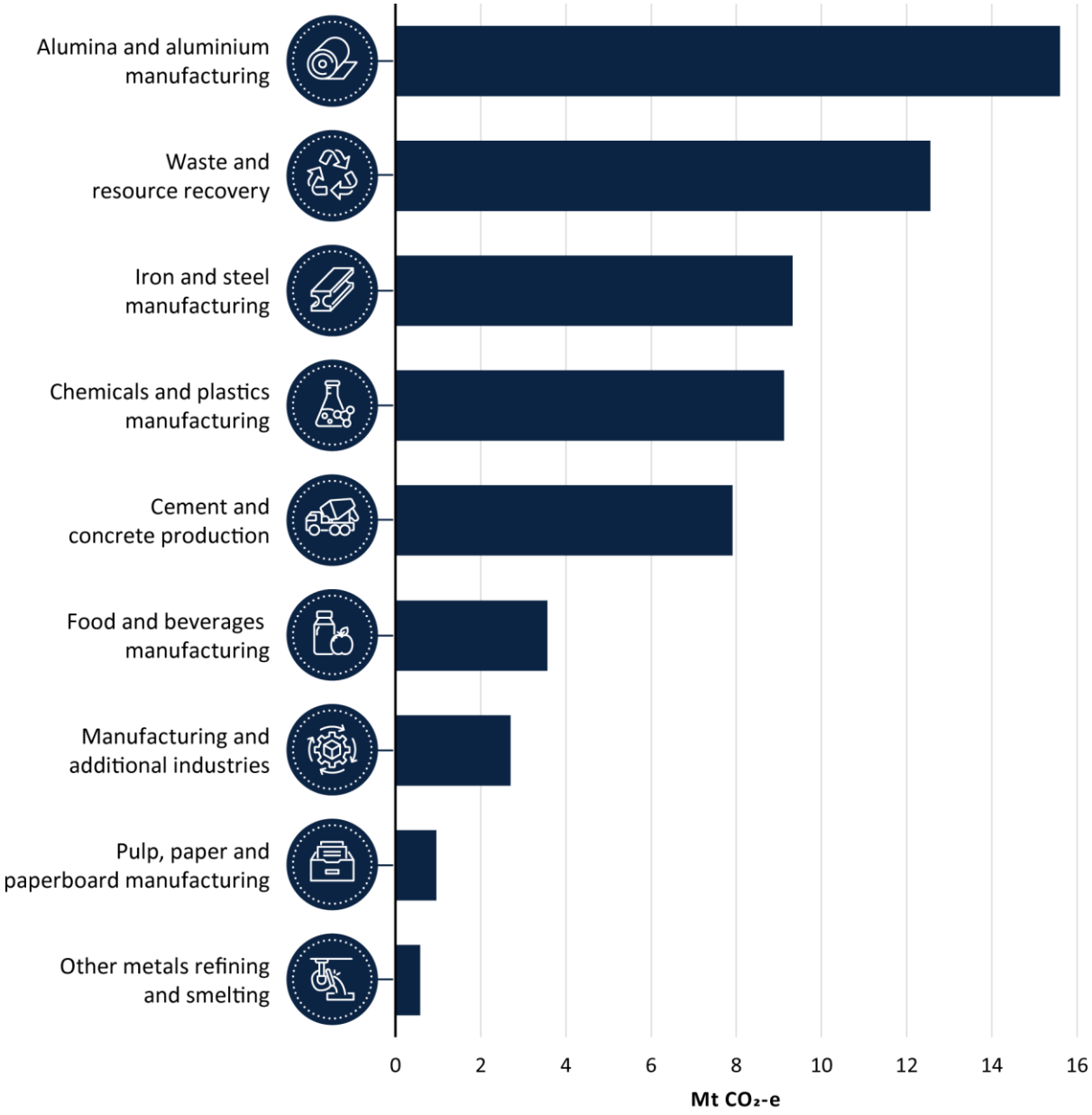


Figure 2: The 9 subsectors covered within the Industry Sector Plan and their associated scope 1 emissions in 2024 (in Mt CO_2-e). 'Manufacturing and additional industries' include those in glassmaking, battery and clean energy technologies, and data centres (see Appendix B). The Industry Sector Plan refers to these 9 subsectors.

These 9 subsectors represent 120,000 Australian businesses that generated $205.8 billion in gross value added (GVA), the equivalent of 7.7% of GDP, in 2023–24. Australia's industrial sector provides over one million jobs, which is approximately 8% of Australia's total employment.

Australia's industrial sector represents 14% of the economy's scope 1 emissions (DCCEEW, 2025a). Of the 9 industrial subsectors, 5 represent almost 90% of industrial scope 1 emissions:

- alumina and aluminium
- waste and resources recovery
- iron and steel
- chemicals and plastics
- cement and concrete production.

Industrial facilities, particularly alumina and aluminium, steelworks and datacentres, are also large electricity and energy users.

Key activities that contribute to scope 1 emissions from industry include:

- **Process heating** emissions from the combustion of gas, coal and oil to create heat and energy for industrial activities. For example, alumina, steel and food and beverage manufacturing burn these fuels to generate heat for calciners, furnaces and boilers.
- **Industrial processes** that produce greenhouse gases because of the feedstock and reactions needed for their production. Traditional cement, iron and ammonia production rely on chemical reactions that produce greenhouse gases.
- **Decomposing organic materials** producing methane emissions that can escape into the atmosphere, such as from sewage, landfill and industrial wastewater.

The Australian Government has committed over $22.7 billion towards a Future Made in Australia. This agenda aims to maximise the economic and industrial benefits of the global net zero transition and secure Australia's position in the global landscape. The Industry Sector Plan is part of this effort.

We developed this plan through targeted engagement. We heard how many Australian industrial businesses, including large and export-focused businesses and forward-looking small and medium-sized businesses, are already taking steps towards net zero. This plan also uses findings from concurrent consultation processes including the Climate Change Authority 2024 Sector Pathways Review and the DISR Green Metals Consultation Paper.

In the immediate term, Australian industry is facing multiple significant challenges transitioning to net zero. These include global market disruptions driving volatile energy prices, limited opportunities to electrify in some sectors, aging infrastructure and intensifying competition in global markets. Sectors such as smelting, cement, glass, and ammonia production are particularly challenging to decarbonise. As Australia pursues the Future Made in Australia agenda and seeks to grow its manufacturing base, we must address these transitional pressures. This will ensure our long-term energy security, industrial competitiveness and economic resilience.

The most critical challenges are to efficiently deliver and use gas and electricity as industries move towards net zero, accelerate the rollout of renewable electricity and fill technology gaps for certain high heat industrial processes. Maintaining industrial competitiveness and capabilities during the transition period is equally important to set us up to achieve our net zero and Future Made in Australia ambitions. Alongside this plan, the Net Zero Plan and the Electricity and Energy Sector Plan explore these challenges and how industry and governments are addressing them.

Achieving the industrial net zero transition will be complex. It will need careful regional planning, a skills ready workforce and reliable and affordable access to renewable energy. It will also need significant capital investment. But decarbonising Australia's industrial sector presents opportunities that will benefit communities and the broader economy. The Industry Sector Plan sets out a way for community, government and industry to work together to achieve these opportunities: to reduce emissions, develop new export opportunities and promote economic growth.

The Net Zero Industry Sector Plan sets out a pathway around 3 principles:

Emissions reduction

An industrial sector that supports Australia's national trajectory to net zero by 2050 and meaningfully contributing to the 2035 target of 62–70% below 2005 levels emissions reduction.

Competitive industries

A competitive, diverse and higher value industrial sector supported by affordable energy to capitalise on Australia's comparative advantages.

Benefits for all Australians

Fit--for--purpose industry policies to ensure a just and equitable transition for our regions, businesses and workers.

The industrial decarbonisation opportunity

Emerging clean energy industries such as green metals and batteries will shape the future of global trade. By decarbonising the industrial sector, Australia has the opportunity to become an integral part of the global net zero economy.

Major economies such as the EU, UK and others are introducing carbon border adjustment mechanisms which will favour suppliers with low and zero-emission goods. The plan for industrial net zero transition includes investing in clean production methods like green metals (iron, steel, alumina and aluminium) and renewable hydrogen. As we transition to net zero, Australian industry will have the opportunity not only to maintain market access but to secure new trade opportunities. Our transition gives us the chance to become a global leader in clean industrial exports and contribute to global and regional decarbonisation efforts.

Green metals are a central component of the Future Made in Australia agenda. Conventional production of steel and aluminium is highly emissions intensive, particularly for iron and steel, which contribute to 8% of all global emissions (IEA, 2023a). The global and domestic energy transition will need significant quantities of green metals. Studies have suggested that Australia's green metals opportunity can be worth tens to hundreds of billions by mid-century (TSI, 2025; Grattan, 2020; Accenture, 2023). Australia is well placed to become a competitive producer of green metals. By investing in local production and using our natural and renewable resources, skills, and world class research, we can play a pivotal role in decarbonising global metals supply chains.

Decarbonisation also enhances Australia's industrial resilience and global reputation. It can encourage innovation, attract investment and create new jobs in emerging sectors such as clean technology and renewable energy. By embracing net zero, Australian industry not only reduces emissions but also builds a more modern, competitive and productive economy.

Upgrading to energy--efficient technologies, automating systems and adopting cleaner production methods can improve productivity by streamlining operations, reducing waste and improving efficiency. Transitioning to renewable energy and diversified energy sources can reduce exposure to global fossil fuel price shocks and disruptions. These improvements can make industrial processes and operations more agile and resilient in the face of economic risks. Industries also face risks arising from climate change though there are opportunities to strengthen industry adaptation and resilience as explored under the National Climate Risk Assessment and the National Adaptation Plan. Australian industry can strengthen its ability to adapt, compete and thrive in a rapidly changing global landscape.

Pathway to 2050

Economic modelling and analysis by Treasury explores 3 scenarios of Australia's transition to net zero by 2050 (Treasury, 2025). This work informed the Australian Government's Net Zero Plan and sector plans and includes potential economy-wide and sector--specific emissions reductions pathways. Treasury modelling provides useful insights on the potential cost--effective timing, sequencing and size of sectoral contributions to the economy-wide emissions reduction task. The Treasury modelling and analysis serves as part of the evidence base for potential decarbonisation pathways for the Industrial sector.

In this section, we refer to the Baseline Scenario, in which Australia efficiently builds on existing climate policies and trends to achieve its net zero targets. The Treasury's Baseline Scenario illustrates a cost-effective pathway for the industrial sector to contribute to reaching Australia's net zero goal.

Treasury's Baseline Scenario projects that emissions from Australia's industrial and waste sector will reduce from 61 Mt CO_2-e in 2025 to 32 Mt CO_2-e in 2050. Investments in abatement technologies are expected to be a significant driver for this emissions reduction. These technologies include electrification and adoption of less emissions--intensive production processes, which are projected to reduce emissions intensities across the sector by 72% by 2050. Emissions from waste remain a small but persistent source of emissions. Abatement through methods such as landfill gas capture is expected to reduce emissions in the sector by 2.5 Mt CO_2-e by 2050.

This modelling projects that Australia will be able to maintain (and in some cases, expand) its existing industrial capabilities. However, the decarbonisation of Australian industries will not be straight forward. Navigating a pathway to net zero will need careful coordination and planning between governments and the private sector. Treasury's Baseline Scenario presents a case where we have successfully achieved this transformation.

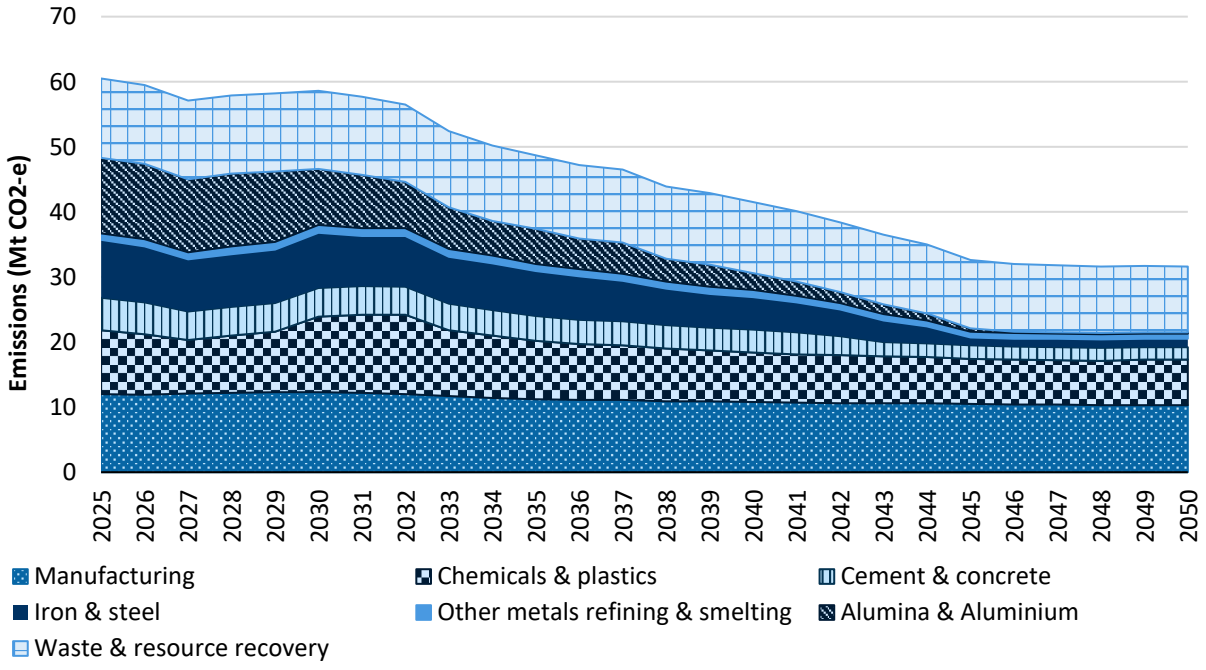


Figure 2: Projected scope 1 emissions for the industrial subsectors Baseline Scenario. Note that manufacturing in this figure includes the subsectors: food and beverage, pulp, paper and paperboard, and manufacturing & additional industries. Source: Treasury modelling (Treasury, 2025).

Treasury's modelling suggests that the industrial pathway to net zero at 2050 could occur in the following phases:

Near term (to 2030): Emissions reductions will largely come from facilities covered by the Safeguard Mechanism deploying commercially available abatement options such as energy efficiency upgrades, electrification where possible, fuel switching from coal to gas and use of alternative fuels. Support measures such as those from the Powering the Regions Fund can help these reductions in emissions intensity.

Medium term (to 2035): The Future Made in Australia agenda supports the iron, steel and alumina sectors to adopt cleaner manufacturing processes as the necessary technologies become available. This transition depends on having access to the necessary renewables and grid infrastructure. It will also rely on scaling up alternative feedstocks such as hydrogen and alternative fuels (see the Electricity and Energy Sector Plan for details). The Safeguard Mechanism will continue driving down emissions for large facilities. Other industrial subsectors will also continue their transition towards net zero, gradually adopting electrification and other abatement technologies as they become commercial and competitive.

Longer term (to 2050): Targeted intervention, including through the Safeguard Mechanism and Future Made in Australia agenda, can potentially reduce emissions from the ammonia, iron and steel, and alumina and aluminium sectors to 5 Mt CO_2-e of emissions, down from 25 Mt CO_2-e in 2025. Overall industry emissions are projected to decline, though residual emissions remain at 2050. Natural gas usage for the industrial sector is likely to decline but will remain part of the energy mix. Gas will continue to play a role in high heat industrial uses, as a feedstock for industrial products and for sectors where it is difficult to fully decarbonise due to technology limitations. As alternative fuels and technologies scale up and become competitive, these users can transition through options such as renewable electricity and hydrogen. Where natural gas remains in use, carbon management technologies will be a potential abatement option.

While scenario--based analysis is a powerful tool in helping inform Australia's net zero pathway, it is not possible to precisely predict the transition. The future is uncertain, and many factors will influence the net zero transition, including changes in technology, global dynamics and community responses.

Actions we can take now

The Australian Government has set an ambitious and achievable emissions reduction target for Australia of 62–70% below 2005 levels in 2035. A strong foundation of Commonwealth policies and initiatives encouraging decarbonisation across the economy will underpin emissions reduction in the industry and waste sectors. These initiatives provide the direction, funding and market mechanisms that support the transition to low--emissions technologies and practices.

Complementing this, state and territory governments play a critical role in reducing emissions through regionally--tailored regulatory settings, planning systems and infrastructure development. Together, all governments can coordinate to support meaningful progress towards reducing industrial emissions while ensuring the continued growth and resilience of our industrial base.

The industry and waste sector can meaningfully contribute to Australia's 2035 target and in many instances can act now. For industrial facilities that use low heat processes, immediate decarbonisation opportunities include using commercial technologies such as heat pumps and electric boilers where there is access to electricity, as well as improving energy performance. Others will need to use new technologies or alternative feedstocks and supply chains.

The Safeguard Mechanism is driving momentum

The Safeguard Mechanism gives industry the clearest and most direct signal to reduce emissions in line with Australia's climate targets. It applies a declining emissions baseline to facilities emitting more than 100,000 tonnes of CO_2-e a year and covers approximately 56% of industrial sector scope 1 emissions. The Safeguard Mechanism supports long-term investment certainty and operational planning as well as encourages investment in commercially viable abatement technologies and alternative inputs. See the Net Zero Plan for more information on the Safeguard Mechanism.

The Safeguard Mechanism will continue to be the main framework for industry facilities to adopt decarbonisation technologies, particularly for heavy industrial facilities. The 2023–24 Safeguard Data Insights from the Clean Energy Regulator shows that Safeguard facilities are already reducing their emissions, abating 2.7 Mt CO_2-e in the first year of operations of the reformed scheme (CER, 2025a). The Safeguard Mechanism can incentivise the uptake of technologies in the near to medium term. These include electric boilers for alumina refining, alternative fuels for cement production, tertiary abatement catalysts for chemicals and improvements to blast furnaces for ironmaking.

Capitalising on Australia's opportunities

The Australian Government is creating a positive investment environment through A Future Made in Australia. This environment lets industry, government and investors share the risks and rewards of investing in clean, low-emissions industries such as green metals production and battery manufacturing. To support the net zero transformation of existing industries and the growth of new industries, the Australian Government has announced over $22.7 billion to promote industrial development where Australia has comparative advantages. This positions Australian industry to compete in a global net zero economy.

A Future Made in Australia is underpinned by a robust National Interest Framework which will ensure significant public investments incentivise private investment at scale. Government support is in 2 streams:

- The Net Zero Transformation Stream for industries that will make a significant contribution to the net zero transition and are expected to have an enduring comparative advantage.
- The Economic Resilience and Security Stream for industries that are necessary for domestic economic resilience and require the encouragement of public funding.

To unlock this opportunity, the Australian Government has introduced several funding initiatives:

- Green Iron Investment Fund: A $1 billion fund to support early movers in establishing commercial-scale green iron facilities that use lower emissions technologies such as direct reduction using gas or hydrogen. Up to $500 million of this fund will be used the help support the Whyalla transformation.
- Green Aluminium Production Credit: A $2 billion initiative to support aluminium smelters to transition further to renewable electricity, helping position Australian aluminium as some of the greenest in the world.
- Future Made in Australia Innovation Fund: A $1.5 billion fund that includes $750 million to support the new technologies needed for green metals through pilot and demonstration projects, and early-stage development.
- Battery Breakthrough Initiative: A $500 million fund to strengthen economic resilience and critical battery manufacturing capabilities, particularly those for high-value battery products in Australia's areas of competitive advantage.
- Green Metals Innovation Network: A $10 million network run by the CSIRO in collaboration with the Heavy Industry Low-carbon Transition Cooperative Research Centre, which brings together research, government and industry to address key technical and economic challenges for green metals.

The Australian Government is also funding co-contributions to capital investment and providing attractive financing options through initiatives to support decarbonisation and low-emissions technologies. The **$15 billion National Reconstruction Fund** (NRF) finances investments in priority areas like renewables and low emissions technologies to support early-stage startups, growth-stage companies and mature businesses. The **Net Zero Fund** will be a new **$5 billion sub-fund of the NRF** to support major investments by large industrial facilities in decarbonisation and energy efficiency, and scale up manufacturing low emissions technologies. The Net Zero Fund will buttress and modernise domestic industrial capability. The funds will be drawn from existing NRF capital and will be a refocusing of the NRF's priorities. The **Powering the Regions Fund** will continue to support a range of decarbonisation investments in Australian industry through:

- the $600 million Safeguard Transformation Stream (STS)
- the $400 million Industrial Transformation Stream (ITS)
- the $400 million Critical Inputs to Clean Energy Industries (CICEI) programs.

The STS and ITS will open new rounds soon. The Australian Government will continue to consider the needs, resourcing and priorities of the fund over time in light of program priorities, the Net Zero Plan and this sector plan.

The **Clean Energy Finance Corporation's Rewiring the Nation** program further supports industrial decarbonisation through electrification and renewables. Rewiring the Nation provides low-cost finance to expand, modernise and connect renewables to Australia's electricity grid – particularly transmission lines and renewable energy zones. This enhanced grid infrastructure allows large-scale renewable energy generation to reach industrial centres, supporting the shift towards renewable electricity. The **Capacity Investment Scheme** provides a long-term revenue-underwriting framework that lowers investor risk for new renewable generation and firming resources (like battery storage). The **National Electricity Market wholesale market settings review** will further help to deliver reliable, competitively priced and secure electricity services. Together, these initiatives allow industries to electrify processes, reduce exposure to volatile fuel markets and adopt renewables at scale – making meaningful, practical industrial decarbonisation achievable. Some important technologies that these measures can enable include deployment of heat pumps and electric boilers.

The **Future Gas Strategy** and **National Hydrogen Strategy** are vital pillars to Australia's industrial decarbonisation by supporting the scale up and adoption of alternative fuels and inputs. The Future Gas Strategy outlines how gas can support the transition towards renewable energy, especially where electrification is not yet viable. Consistent with Future Gas Strategy, the **Gas Market Review** will examine existing government policies and ensure sufficient gas supply in the longer term. Switching from coal to gas is also an important transition step for industries to reduce their emissions before alternative lower emission inputs and technologies become available.

Renewable hydrogen is critical to industrial decarbonisation for key subsectors. The National Hydrogen Strategy will guide Australia's production, use and export of hydrogen. The Australian Government's **Hydrogen Headstart** program and Hydrogen Production Tax Incentive helps catalyse renewable hydrogen and clean energy industries. These strategies and supporting measures are particularly important for industries that require renewable hydrogen such as green iron and green ammonia production.

Green industries that are supported by the Future Made in Australia investments help deliver a stronger Australian economy. As the global economy decarbonises, existing Australian fossil fuel exports will decline. Clean industries could offset the loss of fossil fuel export revenue. In Treasury's Renewable Exports Upside Scenario, export revenue from green commodity sectors is projected to reach $178 billion in 2050, provided there is effective coordination, strong ambition and steady technological progress.

States and territories

Australian governments are increasingly aligning their efforts to coordinate industrial decarbonisation, recognising the need to reduce emissions from hard to abate sectors while maintaining economic competitiveness. All governments are working together to develop and deploy low-emissions technologies, including renewable hydrogen, carbon capture and storage, and electrification of industrial processes. This coordination is critical to ensuring regulatory consistency, supporting shared infrastructure investments and planning the industry transition across jurisdictions.

Australian states and territories are actively developing and implementing strategies, legislation and roadmaps to reduce emissions and support the industrial transition. The state and territory governments are working in close alignment with Australia's ambitious and achievable target of net zero by 2050. All governments are collaboratively advancing Australia's industrial decarbonisation through the National Transformation Principles. These underscore a shared commitment to a fair and inclusive transition, emphasising place-based approaches, First Nations partnerships and regional economic diversification. This collaboration is exemplified through the National Energy Transformation Partnership, the Capacity Investment Scheme and Renewable Energy Transformation Agreements.

Pathways to decarbonisation

Immediate decarbonisation opportunities are available for industrial facilities that use low heat processes. These facilities can use commercially available technologies such as heat pumps and electric boilers and optimise their energy efficiency. Industrial sub-sectors that use high heat will be on a slower decarbonisation trajectory. They will need new technologies or alternative feedstocks and supply chains to support their transition (Climate Change Authority, 2024). The 4 key areas of decarbonisation focus are:

1. Optimise energy use now to reduce costs

Energy performance upgrades to optimise energy use across the economy could achieve more than 13% of the emissions reductions needed to achieve net zero by 2050 (ANZ; EEC, 2024). It is particularly important for the industrial sectors (DCCEEW, 2024a) and is the first logical step in the decarbonisation pathway for all business in the 9 sub-sectors. Energy performance upgrades will deliver immediate benefits, are deployable now, and will help reduce the cost of future upgrades (IEA, 2025a).

Energy performance is also a pathway to modernise Australian businesses, improving competitiveness and productivity while reducing emissions (even in hard-to-abate sectors). **Energy efficiency** upgrades that use less energy to do the same job, is an ideal first step in the decarbonisation of industrial processes and can achieve immediate reductions in emissions and energy costs. For example:

- The use of heat recovery or thermal energy storage to reduce the amount of gas needed for process heat and to reduce emissions. Thermal energy storage systems can also help businesses better harness renewables and solar to further reduce operational costs (CSIRO, 2023).
- Upgrading old equipment such as pumps, refrigeration and hot water systems to improve efficiency. In addition to being more efficient, upgraded equipment typically operates more quickly, with more capacity for optimisation through the incorporation of digitisation and AI technologies. For example, a new air compressor helped a paint maker reduce electricity use by 23% (ANZ; EEC, 2024).
- Deploying smart technologies to help monitor and optimise manufacturing processes and energy use.

Many of these energy efficiency measures can be deployed now using commercial technologies that do not require costly whole of plant upgrades. Studies have shown that energy efficiency can deliver an average 11% per annum in energy savings, with some having a payback period of under one year (IEA, 2025b). The **$56.7 million Energy Efficiency Grants for Small and Medium Sized Enterprises** program supports businesses to upgrade or replace inefficient equipment and implement other energy efficiency activities. The program assists businesses lower their energy use and improve their energy efficiency.

Industries can also optimise energy through **demand flexibility** to better harness times of peak renewable generation where cost of electricity is low. Demand flexibility is discussed in further detail in the 'Enabling the Transition' section below as well as in the Electricity and Energy Sector Plan, but in summary, demand flexibility for industry includes:

- Adjusting processes to take advantage of time of use tariffs e.g. minimise production when renewable generation is low and maximise production when renewable generation is high.
- Use of energy storage such as batteries or electric thermal energy storage to load shift and reduce industrial demand on the grid in times of low renewable generation.

Box 1: Orora Glass – World leading efficiency for its glass furnace

Orora is a provider of packaging solutions for the beverage industry, including glass bottles and aluminium cans. As part of its sustainability actions, Orora has recently commenced operation of its upgraded oxyfuel furnace for its wine glass furnace at its site in Gawler, South Australia. This upgrade was supported by federal grant funding under the Modern Manufacturing Initiative and moves the Orora glass furnace into the 10% most energy efficient furnaces worldwide (Orora, 2025).
By removing nitrogen and heating a mix of oxygen and natural gas, the new oxyfuel furnace is reducing emissions from CO_2 by 25% and nitrogen oxides by up to 80%, all while enabling a furnace energy reduction of up to 30%.

Enabling upgrades to optimise energy use

Many industry sector businesses do not understand where, when, and how they use energy. Improving business awareness of their energy use is therefore a crucial first step to help them to identify where they need to focus investment to optimise energy use. Business can gain insights about their energy use through monitoring or metering systems or by engaging an energy auditor to help inform their upgrade opportunities. The Australian Government is investing in the development of the **National Energy Performance Strategy**, which will provide a long-term framework to coordinate and accelerate actions to improve energy performance. This includes assisting businesses and industry overcome barriers to energy performance, including a lack of awareness of benefits and lack of in-house skills.

For demand flexibility, some industries are already actively participating, often through agreements with retailers. However, widespread demand flexibility from industry is currently limited by financial risk, high set-up and operational costs, and lack of revenue certainty (Nelson, Conboy, Hancock, & Hirschhorn, 2025). These issues make it difficult for businesses to assess their opportunities to engage and invest accordingly. The **National Electricity Market Wholesale Market Settings Review** panel is looking to investigate solutions to address these barriers and encourage more demand flexibility participation.

2. Electrify processes where possible

Electrification, which replaces processes that use fossil fuels with electric equivalents that can be powered by renewable energy, is a primary pathway for decarbonisation for industries. There are electrification opportunities across a range of subsectors, including in food and beverage manufacturing, green alumina and green steel production. Electrification of industrial processes also helps reduce gas use in the electrified industry sectors, freeing up gas supplies for industries that do not yet have viable alternatives. Promising electrification technologies include:

- **Heat pumps** to replace gas heating for low temperature processes in food & beverages. Heat pumps use electricity and refrigerants to more efficiently deliver heat and can be over 4 times more efficient than traditional gas boilers (DCCEEW, 2023).
- **Electric boilers** to replace coal and gas boilers, particularly for alumina digestion which is a significant source of industrial emissions. Electric boilers likely need to be coupled with low-cost renewable energy to be economically viable (Deloitte; ARENA, 2022).
- **Electric Smelting Furnace (ESF)** for example in Pilbara ironmaking. This electrification technology helps remove impurities and will enable green steelmaking using Australian Pilbara ore. It is currently in pilot phase (BlueScope, 2024) (Fortescue Metals, 2025).

While electrification may require higher up-front capital costs, they can provide operational benefits including improved energy efficiency, better ability to integrate digital technologies, and productivity improvements. Electrification technologies can also take advantage of on-site solar or battery assets to reduce the need to purchase electricity from the grid, helping to reduce energy costs and mitigate potential grid capacity limitations or other constraints. For example, heat pumps typically have higher capital costs than the gas-fired boilers they replace, but they are highly efficient and can deliver operational cost savings for a potential payback period of under 3 years if implemented appropriately (A2EP, 2022). See Box 2 below.

Box 2: 3 Ravens Brewery – Benefits from electrification

3 Ravens is a craft Brewery located in the northern suburbs of Melbourne that has moved to 100% electric operations. In 2020, they installed a cool roof and 74 kW of solar PV, this saved energy and improved temperature management. In 2023, they partnered with Regenerate Engineering and A2EP to improve efficiency and minimise waste (3 Ravens, 2025). A CO_2 chiller heat pump was also installed, supported by funding from the Australian Renewable Energy Agency (ARENA) and can operate in different modes depending on the heating or cooling required (Future Heat, 2023). A thermal battery and upgraded distribution systems were also added. Because of these electrification upgrades, 3 Ravens now produce 84.78% of their own electricity, and can brew 4 times more beer without increasing energy use (3 Ravens, 2025).

Enabling electrification

Reliable access to appropriately priced, firmed renewable energy is needed to underpin industrial decarbonisation, and electricity supply will need to double or triple from current levels by 2050 to meet demand and enable uptake of electrification technologies (Climate Change Authority, 2024).

Significant private investment from networks and renewable developers will also be crucial as governments will not be able to deliver the grid transformation alone. The Electricity and Energy Sector Plan outlines a framework to deliver sufficient renewables to support industrial decarbonisation (further detail in the 'Enabling the transition' section). The **Powering the Regions Industrial Transformation Stream** supports a range of industrial decarbonisation solutions relating to electrification, energy efficiency, low emissions processing and fuel switching.

3. Switch to alternative fuels and inputs

Industrial facilities can also consider adopting alternative fuels and inputs such as low carbon fuels, renewable gases, and other alternative inputs which can reduce emissions when other electrification options are not viable, such as in chemical production, ironmaking, and cement production.
Many alternative fuels and inputs are key drivers for new economic opportunities. For example, the production of renewable hydrogen, supported by the Future Made in Australia agenda, is a key input to produce green iron and green ammonia, both of which are significant future clean export opportunities. Increased adoption of circular economy practices and the sustainable use of bioresources represent other areas of opportunity and innovation. A selection of alternative fuels and inputs are highlighted in Table 1.

The use of alternative inputs such as the adoption of inert anodes in aluminium smelting or a switch to lower global warming potential refrigerants, will also be needed to reduce emissions from synthetic greenhouse gases. Abatement options for synthetic greenhouse gases are examined in further detail under the Net Zero Plan and the Built Environment Sector Plan.

Table 1: Alternative fuels and inputs, their applications, and actions to support their deployment

Alternative fuel/input	Applications	Current actions and future steps
Natural gas Natural gas can replace coal as a transition fuel in some applications to reduce emissions intensity, though it will not be able to eliminate emissions.	Substitute for coal to deliver process heat (alumina, cement, etc.), replace coal as a reducing agent for ironmaking (gas-based DRI)	Gas market tightness is likely to impact gas supply and prices. The Future Gas Strategy outlines the Australian Government's plan for managing these challenges and the current Gas Market Review will identify improvements to ensure sufficient gas supply in the longer term.
Hydrogen Hydrogen can be produced using renewable electricity and can be a clean alternative to gas and coal	Feedstock (ammonia), chemical reactant (direct reduced iron), fuel source for high temperature applications (alumina calcination)	The National Hydrogen Strategy 2024 provides the framework to position Australia as a global hydrogen leader. The Hydrogen Production Tax Incentive and the Hydrogen Headstart program are helping to increase availability and affordability of hydrogen as the industry scales. The Australian Government has also invested more than $500 million to support and co-fund common infrastructure investments and the formation of hydrogen hubs in regional Australia. Hydrogen is a key priority of the Future Made in Australia agenda, and in decarbonising many industries.
Bioresources Bio-derived fuels and inputs from agricultural waste, forestry residue, and waste-water treatment that can substitute fossil fuels	Process heat (biogas, biomass, biomethane), electricity generation (bagasse), feedstocks (biomethane for chemicals)	The cost and sustainability of bioresources can vary. Access and distance to bioresources are key factors. Bioresources are enablers for the sector plans. ARENA released Australia's Bioenergy Roadmap in 2021, which highlights the potential for Bioenergy in Australia. Modelling shows that bioenergy has the potential to provide up to 20% of Australia's total energy consumption by the 2050s. (Enea, Deloitte, ARENA, 2021)

Alternative fuel/input	Applications	Current actions and future steps
Circular Economy Resource recovery and reuse at end-of-life to turn waste materials into manufacturing inputs	Material recycling (scrap metals, plastic waste), waste recovery (mineral carbonation), process heat (biogas from waste treatment)	Supply chains and regulations for circular economy activities can take time to develop but Australia is progressing its circular economy transition through embedding principles into programs and policies. Australia's Circular Economy Framework provides the blueprint for prioritising national action through supporting material recovery and domestic reprocessing across industrial sectors. The Government has committed to doubling Australia's circularity by 2035, which is anticipated to reduce greenhouse gas emissions by 14% in the same timeframe.
Low carbon building materials Additives and alternatives to building materials that traditionally have high emissions	Supplementary cementitious materials (blast furnace slag to substitute clinker), new materials (geopolymers)	Only certain cement types can be used in concrete under the relevant Australian standard for concrete. This inhibits the uptake of lower emission technologies in Australian cement production and use. Updates in Australian Standards and regulations and promoting market adoption will help increase the use of low carbon building materials.

Box 3. Alternative industrial process heat option through concentrated solar thermal

Mars Petcare in Wodonga, Victoria, has installed a $39.3 million Solar Thermal Plant with the aid of a $17.2 million grant from ARENA. The 18-megawatt Parabolic Trough Concentrated Solar Thermal (CST) plant will provide up to 10 hours of thermal energy storage for cooking pet food (Mars, 2024). The project is expected to reduce their total natural gas consumption by over 50%, leading to an annual carbon reduction of up to 4,000 tons (ARENA, 2025). The CST plant uses mirrors to concentrate sunlight to produce thermal energy, the heat is then captured and stored and can be dispatched on demand for a wide range of industrial process heat applications. CST combines with electrical thermal energy storage (eTES) systems to displace gas for steam-based manufacturing processes.

4. Invest in technology opportunities to support the transition

All subsectors have technology opportunities that are deployable now, though additional technologies are required for most subsectors to reach net zero. This is especially the case for hard to abate industrial processes due to high process temperature requirements and complex production processes. New technologies and innovations will be important for subsectors such as iron and steel, aluminium and alumina, cement and chemicals. Some potential decarbonisation technologies by subsector are listed in Table 2.

Table 21: Potential deployment timeframes for a selection of emissions reduction opportunities in each subsector in the near, medium and long term. Technology pathways will vary by facility.

Subsector	Near term (by 2030)	Medium term (by 2035)	Longer term (by 2050)
Alumina and aluminium 	• Double digestion	• Thermal energy storage • High temperature heat pumps • Electric boilers • Mechanical vapour recompression	• Electric/Hydrogen calcination • Inert anodes
Cement and concrete production 	• Alternative fuels • Supplementary cementitious materials	• Design and concrete innovation • Geopolymers	• Electrification of high temperature thermal processes* • Carbon management tech
Chemicals and plastics 	• Tertiary abatement catalysts • Waste heat recovery • Introduce renewable hydrogen for ammonia	• Biotechnology*	• Zero emissions renewable hydrogen feedstocks
Food and beverages 	• Food waste avoidance • Electric/biomass/biogas boilers • Heat pumps	• High temperature heat pumps • Further electrification	• Continued adoption
Iron and steel 	• Electric Arc Furnace • Gas-based DRI • Blast-furnace partial mitigation • Increase scrap steel use • Alternate feedstocks (biochar)	• Beneficiation and pelletisation • Electric Smelting Furnace • Hydrogen/gas mix DRI	• Hydrogen-based DRI • Hydrogen plasma smelting* • Molten Oxide Electrolysis* • Flash ironmaking*
Manufacturing 	• Process optimisation • Alternative fuels	• Continued adoption of process optimisation and alternative fuels	• Technologies currently in early stages of development
Metals refining and smelting 	• Energy and materials efficiency	• Electric smelters	• Technologies currently in early stages of development

Subsector	Near term (by 2030)	Medium term (by 2035)	Longer term (by 2050)
Pulp, paper and paperboard 	• Bioresources • Electric boilers	• See common opportunities	• Continued adoption
Waste and resource recovery 	• Gas capture and use • Diversion of organic waste	• Biogas and biomethane production • Biotechnology	• Continued adoption
Common opportunities 	• Circular economy • Energy performance • Onsite renewables • Use of lower GWP refrigerants • Process optimisation • Material substitution	• Further electrification • Electric thermal energy storage (e-TES) • Further development of new low GWP alternatives • Optimisation via AI	• Alternative fuels, including hydrogen • Carbon management tech • Technologies currently in early stages of development

*Potential breakthrough technologies that are in earlier stages of development

Research and development and technology innovation

Australia is an established global leader in world-class research and science excellence. There are a range of measures to support the development of technologies and innovations required to help industries reach net zero.

Commonwealth agencies such as the Commonwealth Scientific and Industrial Research Organisation (CSIRO) play a vital role in accelerating the development of technologies and innovation. This includes work from the CSIRO energy mission to lead the development of technologies and knowledge creation that drive low-cost electrification and decarbonisation of our major industries and exports. CSIRO's research infrastructure is critical in this role, providing world class facilities to deliver on Australia's science ambitions and support collaboration across research, industry and community sectors.

Australian Government programs funded through ARENA offer critical support towards industrial decarbonisation research, development, commercialisation and uptake. To support the net zero transition, the **$1.5 billion Future Made in Australia Innovation Fund** provides grant funding to support pre-commercial innovation, demonstration and deployment of renewable energy and low emission technologies across green metals, clean energy technology manufacturing and low carbon liquid fuels. The **$40 million National Industrial Transformation Program** supports industrial decarbonisation projects targeting investment in electrification, fuel switching or energy efficiency, or critical enabling infrastructure. Support ranges from feasibility stage projects through to demonstration and deployment stage projects.

Innovation and commercialisation are major levers to increase the commercial success of SMEs through differentiation and competitiveness. Research from the Industry Innovation and Science Australia showed medium-sized businesses have the highest rate of innovation-active businesses (at 71%) among Australian businesses, higher than large businesses (IISA, 2023). The **Research and**

Development Tax Incentive encourages companies to innovate by offsetting some of the costs of eligible R&D activities, which could include research and development focussed on decarbonisation of industrial processes. Up until 2023–24, over $7.5 billion of R&D expenditure was claimed under the Research and Development Tax Incentive by green metals related projects. The Australian Government's cooperative research centres (CRCs) foster high quality research partnerships between industry and research organisations to support the competitiveness, productivity, and sustainability of Australian industries. The **Heavy Industry Low-carbon Transition (HILT) CRC** is focussed on de-risking and accelerating the technology pathways to transition steel, iron, alumina and cement industries.

The Australian Government is also supporting the growth of enabling capabilities such as artificial intelligence (AI) and quantum technologies to enhance our ability to collect, collate, and analyse vast amounts of data. These digital insights can support the transition to green practices through improved energy utilisation, process optimisation and smart decision-making to boost productivity. Biotechnologies can also play a role, providing biobased substitute feedstocks for fossil fuels, see Box 4. These enabling capabilities have been identified as a priority area under the National Reconstruction Fund and is further supported through the **National AI Capability Plan** and the **National Quantum Strategy**.

The Strategic Examination of Research and Development builds on this to deliver an effective R&D system and increase the benefits of science, research and innovation for Australia. This includes getting more value from research investments, growing business investments in R&D, and leveraging our scientific strengths to address national priorities.

Box 4. Innovative biotechnology solutions to reduce emissions and plastics waste

Samsara Eco and Uluu are 2 Australian companies offering innovative biotechnology solutions to reduce the carbon intensity of plastic production by keeping materials in use for as long as possible (Samsara Eco, 2025; Uluu, 2024). Uluu produces biodegradable plastics derived from seaweed. Samsara Eco has developed novel enzymes to infinitely recycle plastics at scale. Both manufacturing processes have a low carbon footprint as they rely on renewable resources and use lower temperatures compared to traditional methods. This results in reduced emissions through circular processes.

Enabling the transition

Industrial decarbonisation is not just a technical challenge; it is a complex transformation that demands focused attention on a range of key enablers. This includes tailored regional transition planning, securing social licence to operate, a skilled and adaptable workforce, reliable and affordable access to renewable energy, and sustained innovation in technology.

Our regions can be the driving force

The industrial net zero transition will have a profound impact on regional Australia, where much of the country's industrial activity takes place (see Figure 4**Figure 43**). The heavy industry regions of Australia today were largely developed decades ago in response to proximity to large fossil fuel-based energy sources. As these industrial regions transition, it is important that industrial decarbonisation deliver real benefits to the people and communities of the regions in line with the guiding principles of the Australian Government's Regional Investment Framework.

Industrial transformation can create significant opportunities for regional revitalisation and economic diversification. Investing in modern onshore metal processing capabilities, for example, supports essential services within industrial ecosystems by connecting mines to end users of refined metals, leverages existing local resources and infrastructure and enables vertically integrated supply chains to make onshore manufacturing more resilient. These regional connections and supply chains are also important enablers for the decarbonisation of industries, particularly those that require alternative inputs such as bioresources (including biogas, biomethane and biochar), circular economy, and alternative fuels (see **Error! Reference source not found.**1).

Existing industrial regions not only contain the smelters, refineries and facilities for a net zero economy and regional livelihoods, they also have the critical skilled workforce, land availability, local supply chains, and much of the required infrastructure including ports, rail and housing to attract new investments and projects such as green metals. Growing new industries and retaining our regional industrial capability and the communities and ecosystem that they provide for will be critical for Australia's industrial transformation and long-term economic resilience.

Future industries such as green metals may also require the development of new industrial regions. These locations will be dependent on the availability of renewable energy, nearby mineral/ore reserves, access to infrastructure, and future trade and industry opportunities, and community support for local industry development. With the right planning, enabling infrastructure and skills development, regional areas can play a pivotal role in Australia's net zero economy, ensuring the benefits of decarbonisation and emerging industries are widely shared and that communities traditionally reliant on emissions-intensive industries are not left behind. This consideration for communities is an important part of the Future Made in Australia agenda, as highlighted by the Community Benefit Principles to guide policy making and investment decisions.

The industrial transition will also cause significant changes to the local industrial infrastructure and business practices of large employers and will require community buy-in. Social licence and ongoing community support can be compromised through poor practices, leading to potential community backlash. Practices such as early and inclusive community consultation, benefits sharing, and job upskilling can maintain and increase social licence. As industries decarbonise, regional economies and their communities and workers will also face opportunities as well as risks. For example, communities

that have traditionally relied on fossil-fuel based industries will also need a coordinated approach to retraining and reskilling the local workforce.

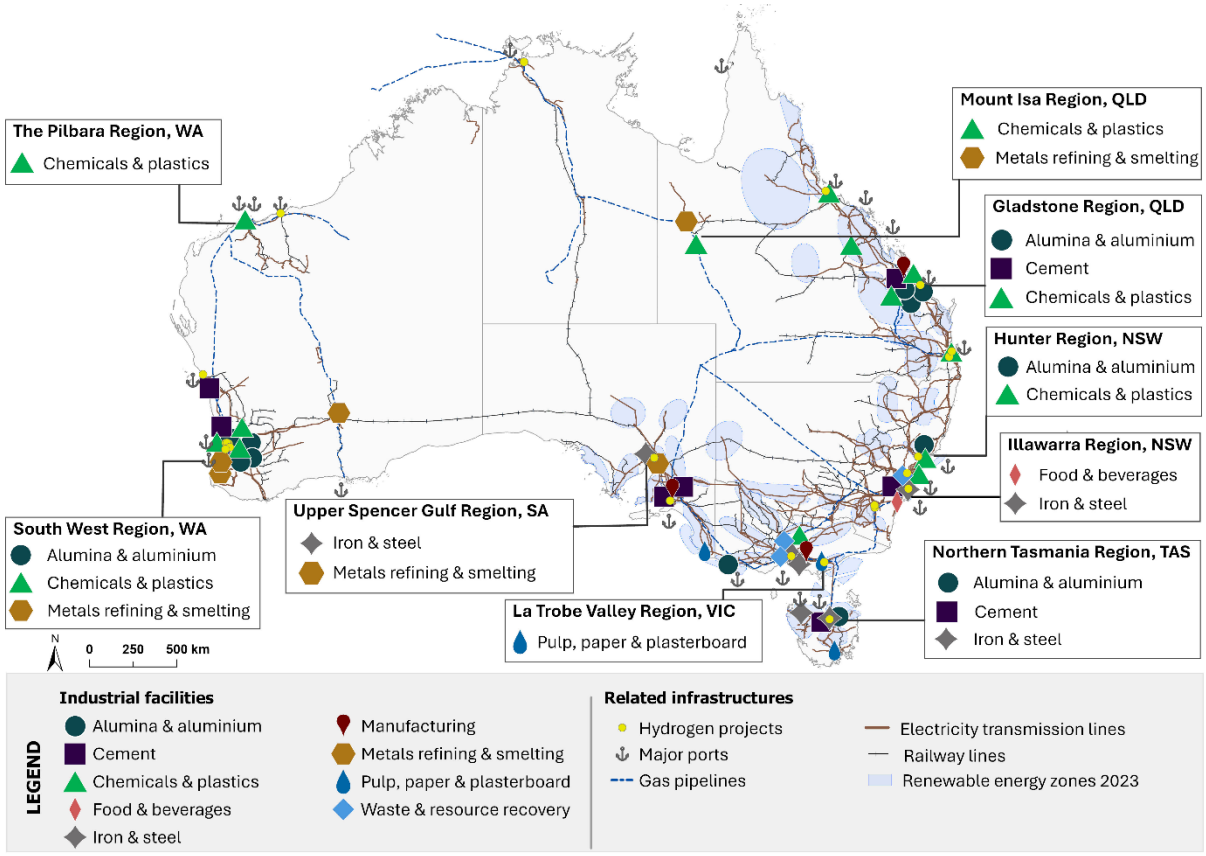


Figure 43: Key industrial facilities co-located in regional areas with relevant infrastructure. This map is intended to be a high-level representation only. DISR created this map based on data from the Clean Energy Regulator (CER), Geoscience Australia (GA) and Australian Energy Market Operator (AEMO).

Net Zero Economy Authority

The Net Zero Economy Authority (the Authority) is shaping a better future for industrial regions, communities and workers in the net zero economy. As key industrial regions transition away from fossil fuels, the Authority will help support regions, communities and workers to manage the impacts, and share in the benefits, of the net zero economy. This is supported by the Community Benefit Principles under Future Made in Australia.

The Authority is working closely with the regions that will be most affected by Australia's transition to a net zero economy. This includes helping workers in coal and gas facilities affected by the transition to prepare for and find new well paid, safe and secure jobs, supporting affected communities to prosper through economic development and investment and being a trusted and influential voice to build understanding of, and shape policy on, the regional net zero transition. Current focus regions for the Authority include Collie, Central Queensland, the Hunter, Latrobe, Pilbara and Upper Spencer Gulf. The Authority is working with communities, including First Nations communities, state and local government, other federal government agencies, regional bodies, unions, businesses and individuals across these regions.

Box 5: The Central Queensland region

Central Queensland is an economic powerhouse, underpinned by manufacturing and mining industries. It is one of the most emissions-intensive places in Australia, accounting for around 14% of national scope 1 emissions.

The emissions intensive industries in Central Queensland include alumina and aluminium production, coal mining, Liquified Natural Gas (LNG), cement, ammonia and other chemical manufacturing. These have been the backbone of the regional economy and transitioning these sectors to clean energy will be critical to Australia's net zero target. While the shift to net zero presents challenges, Central Queensland is well positioned to become a global hub for green metals, critical minerals, biofuels, and potentially defence-related manufacturing, creating new industries and high-quality jobs for local communities.

With a strong legacy of international trade and industry, supported by its world-class deepwater port, Central Queensland is a strategic hub for investment. Progress is underway with a strong pipeline of renewable projects complemented by new industrial developments. This includes Alpha HPA's delivery of Australia's first high-purity alumina processing facility, and Rio Tinto's agreement to power its Boyne aluminium smelter in Gladstone with renewable energy sources from projects across the region.

Workforce and skills

To support the net zero transition, building a skilled workforce for advanced manufacturing is crucial for Australia's economic growth and prosperity. Key areas of focus include attracting young people to manufacturing careers, diversifying the workforce, reskilling existing workers, and modernising training so it is relevant and up to date. In line with findings from Jobs and Skills Australia, considerations in skills, location, timing and preferences will need to be made to deliver targeted, localised and individualised supports to drive successful outcomes for workers and their communities (Jobs and Skills Australia, 2025).

As new technologies are developed and adopted, new skills and specialised training will be required to design, install, operate and maintain future systems. Vocational education and training (VET) system reforms will help deliver an adaptable, skilled workforce resilient to the structural changes of the net zero transition and support micro-credentials in the training system to deliver in-time training to meet emerging and urgent skills needs. Peak bodies, such as A2EP and the Energy Efficiency Council, will be helpful in delivering trusted advice to build industry awareness on the skills necessary to support a specialised implementation workforce. In addition, through the Australian Government's Green Metals Innovation Network, the CSIRO in collaboration with HILT CRC will identify pathways to support a strong Australian metals workforce.

The Clean Energy Capacity Study found that Australia '*can't grow the workforce at the pace and scale required if large groups of the population are excluded, including women, First Nations people, people with disability, and recent migrants whose skills' potential are underutilised*.' (Jobs and Skills Australia, 2023). Creating conditions in the industrial sector that support increased participation from women and other underrepresented groups would help address workforce shortages, in alignment with the Australian Government's ambitions in *Working for Women: a Strategy for Gender Equality*. State-led programs such as, Victoria's 'Making it Equal' and Queensland's Women in Manufacturing, alongside

federal reforms for fair hiring practices, pay transparency, and more inclusive workplaces will be an important aspect of this effort.

First Nations communities to share in the benefits of industrial net zero

Australia's net zero transformation presents a unique opportunity to deepen our engagement with First Nations communities through partnerships that are built on respect, shared value and long-term benefit. As industries transition to cleaner energy and technologies, many projects and their enabling infrastructure (e.g. renewable energy, hydrogen developments) will be located on land with Native Title, rights and interests.

Industrial decarbonisation can empower First Nations communities as key partners in Australia's clean energy future. Working in partnership with First Nations communities, especially during the planning stage, and by creating pathways for employment, training and business participation, industrial decarbonisation can support cultural heritage and economic empowerment.

Meaningful collaboration with First Nations communities is necessary for industries, helping to develop trust with their local communities, avoid costly delays and build new opportunities. The First Nations Clean Energy Strategy can provide a helpful guide to support benefits for First Nations Australians. Engaging collaboratively to achieve positive outcomes for local communities, including First Nations communities is one of the Community Benefit Principles under Future Made in Australia.

Industrial transition will rely on grid infrastructure and access to renewable energy

As industrial facilities such as aluminium smelters, alumina refineries and food and beverage manufacturers increasingly prepare to shift to renewable energy, they require tailored grid infrastructure and renewable investments to support their net zero operations. This includes transmission and distribution grid upgrades, as well as access to the necessary renewable generation and firming. Depending on the location of facilities and the nearby existing grid infrastructure, industries may consider partial or completely off-grid solutions to be a cost-effective method for accessing renewable energy. However, off-grid solutions present their own complications and costs, including the need for sufficient access to land for renewable developments. Most existing industrial facilities will still likely require tailored on-grid connections to support their decarbonisation pathways.

Investment in industrial decarbonisation will require coordinated regional infrastructure planning to deliver renewable energy and firming to industry users. Recent developments such as Rio Tinto's multiple power purchase agreements, comprising 2.7 GW of wind and solar for their assets in Gladstone, show a potential way forward (Rio Tinto, 2025). These agreements will help repower Rio Tinto's industrial facilities with renewables, including the Boyne aluminium smelter, Yarwun alumina refinery and the QAL alumina refinery. Use of offtake agreements can help de-risk investments for industrial decarbonisation, drive large renewable investment, and help negotiate affordable electricity prices. Proactive grid planning from grid bodies such as AEMO, state and federal governments, and network providers to consider industry specific needs will help to reduce the chance of costly delays. Reforming regulatory processes for approvals for renewables and transmission infrastructure will also be key enablers for the renewable rollout.

Industry is an active player in the grid

Continued grid transition and increased share of variable renewables will need to be balanced with demand flexibility from all areas of the economy, including industry. Industry will need to consider options for reducing energy demand when demand and supply balance is tight (e.g. load-shedding), increasing industrial demand when there is excess renewable supply (e.g. load-taking) and providing other grid stability services to help deliver a cost effective system. This industrial demand flexibility is also discussed in the Electricity and Energy Sector Plan and can help optimise grid infrastructure, minimising the delivered cost of renewable electricity and supporting industries to remain competitive.

The Reliability and Emergency Reserve Trader (RERT) process presents an example of demand flexibility arrangements. The RERT is a mechanism for AEMO to maintain reliability by calling on large industrial users such as aluminium smelters (with the necessary assets) to voluntarily reduce their electricity demand during times of tight demand and supply balance to support grid stability. In turn these participating facilities are compensated for these services (AEMO, 2024). While providing these grid services is not a core business for industrial facilities, the RERT represents an example of how industry can play a more active role in the grid while receiving an additional source of revenue. Additional opportunities for demand flexibility are being assessed as part of the National Electricity Market Wholesale Market Settings Review.

Other tools to support demand flexibility include energy performance upgrades and onsite (behind-the-meter) generation and storage. Demand flexibility via onsite energy storage assets (batteries, hot water storage, thermal energy storage etc.) can be particularly useful by providing business with ways to store and use energy independently from the grid for short periods of time. These tools provide opportunities for a more active participation in the grid, such as load shifting and energy arbitrage, providing benefits to both industry and the wider grid.

To encourage the widespread uptake of industrial demand flexibility, the cost and benefits of industrial participation will need to be carefully balanced. Trials such as AGL's Dynamic Pricing Load Flex Trial are currently underway to better understand this balance and is complemented by new market mechanisms and intermediaries such as storage brokers.

Market demand will help de-risk investments

Market demand for lower-emission products will bring confidence for business and enable them to invest in industrial decarbonisation efforts. This is particularly important for industries with low margins such as cement, steel, aluminium and chemicals where significant capital is required for decarbonisation. Strong demand drivers, either through government procurement, regulatory requirements, consumer demand or business commitments to net zero, will help de-risk critical investments such as new boilers, kilns, furnaces etc. needed for net zero.

Work is already underway on this, including through Materials and Embodied Carbon Leaders' Alliance (MECLA), helping to reduce the embodied carbon in the building and construction industry. This helps support the adoption of lower emission products from the steel, cement, aluminium and other construction material subsectors. Additional opportunities are highlighted in other sector plans, many of which rely on inputs from the industrial sector. the built environment sector Plan and Transport Sector Plan have strong linkages to the steel and cement subsectors for the buildout of new buildings and infrastructure. Other opportunities include lower emission explosives and fertilisers from chemical manufacturers for the Resources and Agricultural and Land Use Sector Plans.

Local content policies that encourage use of low emission products also help build momentum in markets, supporting the scale up of manufacturing capability and unlocking advantages from economies of scale.

International market demand for lower emission and green products is also growing and is one of the key drivers for investment and opportunities under the Future Made in Australia agenda. Global demand for green commodities is expanding, driven by government policies such as Europe's Carbon Border Adjustment Mechanism, as well as net zero commitments from businesses around the world. Successfully attracting this international market demand to Australian producers and investments will be key to unlocking a Future Made in Australia and its economic opportunities around green metals and other clean exports. Measures including the Investor Front Door, the Guarantee of Origin scheme, the Sustainable Finance Roadmap and Sustainable Finance Taxonomy are already underway to help streamline global and domestic investments (see also Chapter 10 of the NZP 'Attracting investment to achieve net zero').

Towards net zero

Industrial transition will occur in phases due to complexity and evolving nature of low-emissions technology. A phased transition allows industries to adapt over time while ensuring that investments align with technological readiness, cost-effectiveness and emissions reduction potential.
This approach will vary depending on the subsector, balancing ambition with practical implementation, to help industry maintain competitiveness while progressing towards net zero.

Phase 1: Deploy existing opportunities and planning (near term 2025–30)

Focusing on developing industry knowledge and deployment of existing commercial abatement technologies, subsectors such as food and beverages, and pulp, paper and paperboard will likely be early movers. Overall abatement may be minor but can build momentum within industry.

The Safeguard Mechanism will be an important driver for large industrial emitters. To ensure they are appropriately calibrated, the Australian Government will review Safeguard Mechanism policy settings in 2026–27. As part of the review, the Climate Change Authority (CCA) will advise the Australian Government on the extent to which on-site abatement is being driven by the reforms, and whether any additional incentives are required.

Australia's Carbon Leakage Review was undertaken as part of the 2023 Safeguard Mechanism reforms to assess potential carbon leakage risks and develop policy options to address carbon leakage. Findings from the review found that current Safeguard Mechanism settings are effective at mitigating carbon leakage risk in the short to medium term, but settings for some sectors may need to be augmented with additional measures over time. The Australian Government will release the report from the Review to continue discussions on recommendations with impacted industries and will give further consideration to the issues and whether to implement a border carbon adjustment in the 2026–27 review of the Safeguard Mechanism.

Energy performance upgrades, increasing use of circular economy, switching from coal to gas, and electrification where commercial solutions exist are likely pathways during this time. For industrial abatement to continue at pace, planning for key enablers including grid infrastructure, R&D, skills, and regional coordination will need to be begin in Phase 1.

Phase 2: Widespread adoption of existing technologies and commercialise new tech (medium term 2030–35)

Building on progress from Phase 1, industrial transition will focus on the widespread deployment of commercially available net zero technologies and broader deployment of circular economy practices. Widespread adoption of electrification, energy performance upgrades and other alternative inputs is anticipated for low heat processes such as food and beverage manufacturing. Heavy industries are also expected to deploy commercial technologies such as electric boilers at scale, enabled by the buildout of the renewable grid.

Trials and commercialisation of new technologies are also anticipated ahead of the next phase of decarbonisation. Scale up and build out of the necessary infrastructure, supply chains and workforce for alternative inputs such as hydrogen and bioresources are also likely to begin progressing at pace.

Phase 3: Net zero and new market opportunities (longer term 2035–50)

Significant emissions abatement from across industry is anticipated, particularly for hard-to-abate processes such as high temperature heating in alumina calciners. Much of this would be driven by the technology developments and innovations occurring today. Alternative inputs such as hydrogen and bioresources are also likely at sufficient scale and cost to enable widespread industrial adoption.

This period will also likely see the growth of new industry opportunities in green metals, green chemicals and other areas of comparative advantage. New breakthrough technologies may also be commercialised and deployed during this time and circular economy practices will be widely integrated.

The Climate Change Act 2022 sets up a strong framework to ensure Australia remains on track to reach net zero emissions. It requires the Minister for Climate Change and Energy to report progress through an Annual Climate Change Statement to Parliament, including progress towards emissions targets, and whether current policies are effective. This regular reporting ensures transparency and accountability. It also creates a clear cycle for reviewing and improving climate policies over time.

Together with advice from the Climate Change Authority, the Net Zero Plan and corresponding sector plans will guide the decarbonisation trajectory of industry and the broader economy. Through ongoing monitoring and review, new opportunities for action will be identified. Continued engagement and contribution of stakeholders is fundamental to this process.

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Glossary

Term	Definition
AI	Artificial intelligence
ARENA	Australian Renewable Energy Agency (ARENA). ARENA is a statutory authority that provides research, development and deployment grant funding to improve the affordability and increase the supply of renewable energy in Australia.
Biotechnologies	Biotechnologies harness cellular and biomolecular processes to improve our health, wellbeing, economy and environment. This includes engineering cells that recycle plastics and microorganisms to recover metals from ores
CO_2	Carbon dioxide
CO_2-e	Carbon dioxide equivalent
CRC	Co-operative Research Centre
DCCEEW	Department of Climate Change, Energy, the Environment and Water
DISR	Department of Industry, Science and Resources
DRI	Direct reduced iron
GDP	Gross Domestic Product
GVA	Gross Value Added
GWP	Global warming potential
Mt	Million tonnes
NGERS	National Greenhouse and Energy Reporting Scheme
NZEA	Net Zero Economy Authority
R&D	Research and development
Scope 1, 2 and 3	Scope 1 emissions refer to greenhouse gas emissions released into the atmosphere as a direct result of the activities at a facility Scope 2 emissions are those released in the process of producing the electricity which is generated externally and imported in to power a facility, Scope 3 emissions are other indirect emissions which occur outside the boundary of a facility. Typically, these occur are upstream or downstream of the facility. (CER, 2025b)
SME	Small-to-medium enterprise (non-employing and businesses with 1–19 or 20–199 employees)

Appendix A: Historical emissions

Emission trends to date, and the projections on status quo

Since 2005, the industrial subsectors direct emissions have decreased slightly (Figure A1). Some of the declines can be attributed to the global financial crisis, particularly in the immediate years following 2007 (House of Representatives, 2009). Other declines in emissions are likely a result of improvements in efficiency as well as the closure of industrial facilities over this period.

Emissions have otherwise remained mostly flat, reflecting a stable period of industrial activity. More recent disruptions triggered by the invasion of Ukraine and the accompanying gas price increases are partly responsible for the decreases in emissions in the years 2022 to 2024.

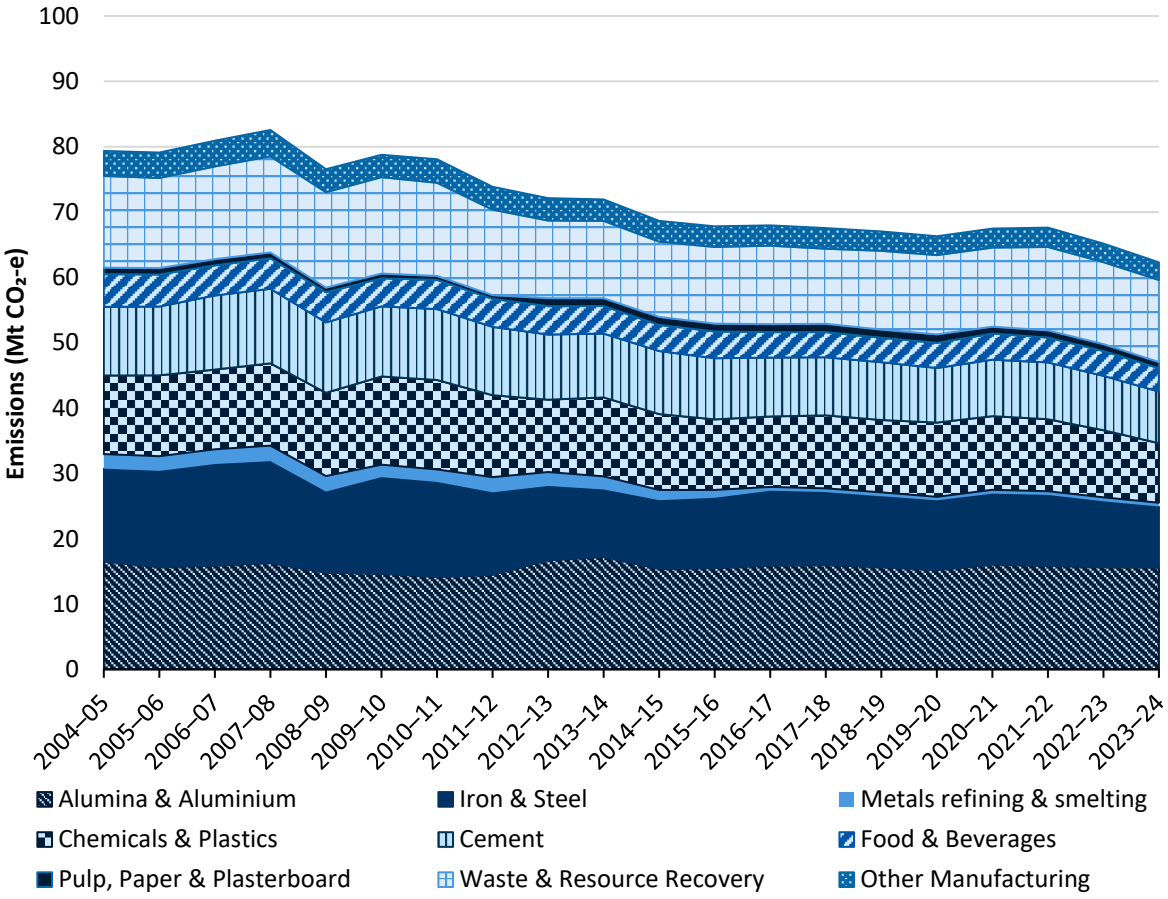

Figure A1. Historic scope 1 emissions of the Industry Sector Plan by subsector from 2005–2024. The emissions estimates are based on national emissions reported in the *Quarterly Update of Australia's National Greenhouse Gas Inventory, December 2024* (DCCEEW, 2025a).

Appendix B: Summary of the Industry Sector Plan subsectors

Aluminium and alumina

Economic context

Number of businesses*	GVA (% of GDP) *	Exports ($m) *	Number of jobs
1,699	0.2%	14,811	26,900

* FY2024

- Australia is globally competitive in alumina and aluminium production, and Australia is unique in having the entire aluminium supply chain, from bauxite mining to finished products.
- Aluminium has a wide range of uses across the economy, including in the automotive and construction industries.

Emissions profile

Scope 1 emissions (% whole-of-economy)*	Safeguard facilities	Safeguard facility emissions (% whole-of-economy)*	Safeguard proportion of scope 1 subsector emissions
3.5%	10	3.4%	96%

* % of Australia's emissions, FY2023-24 (DCCEEW, 2025a; DISR, 2025)

- Emissions are primarily from Australia's 5 alumina refineries and 4 aluminium smelters. Remaining businesses are aluminium fabrication operations with minimal direct emissions.

Alumina

Alumina production generates emissions primarily from 2 processes: firstly digestion, using the Bayer process, which is energy and heat intensive (138–255°C) and secondly calcination, which uses high temperatures around 1,000°C to produce the final alumina product. Conventional technologies use coal and gas to produce the energy and heat required (Deloitte; ARENA, 2022).

Low emissions alumina production technologies are being developed. With 3 Australian demonstration projects at various stages of development (links below).

- Digestion:
  - Alcoa Mechanical Vapour Recompression (MVR) project
  - Electric boilers.

- Calcination:
  - Yarwun Hydrogen Calcination Pilot Demonstration Program
  - Alcoa Renewable Powered Electric Calcination Pilot.

The choice of technology suitable can be facility and ore specific, with multiple pathways to net zero for Australia's alumina industry.

Aluminium

Aluminium's scope 1 emissions are predominantly from the production and use of carbon anodes in the aluminium electrolysis process, resulting in small amounts of perfluorocarbon (PFC) emissions, which is a very potent type of greenhouse gas. Most scope 1 emissions will be abated through substituting carbon anodes with inert anodes, likely available in Australia some time after 2035. Provision of firmed renewable electricity is required prior to adopting inert anodes, as they likely have a higher demand for electricity than conventional carbon anodes and would otherwise result in higher emissions (NRDC, 2023).

Recycling aluminium does not produce PFCs and uses significantly less electricity, also reducing scope 2 emissions. The small scale of Australia's scrap recycling industry results in 95% of Australia's scrap aluminium being exported for recycling (Australian Aluminium Council, 2024). Domestic recycling is limited by the scale of downstream manufacturing of primary aluminium in Australia beyond the extrusion industry

Aluminium facilities are by far the largest consumers of electricity within the industrial sector and economy more broadly. Addressing alumina and aluminium's scope 2 emissions by switching to firmed renewable electricity would make a significant contribution to achieving Australia's net zero ambitions. Traditionally, aluminium production has been sited close to electricity generation and port access.

The alumina and aluminium industry require a coordinated buildout of low-cost and firmed renewables and (potentially) access to affordable renewable hydrogen at scale to fully decarbonise. In Canada and Europe, the sector has located facilities close to historically located hydroelectricity to provide firmed low-cost power at scale, which has enabled zero emissions aluminium production.

Cement and concrete production

Economic context

Number of businesses*	GVA (% of GDP) *	Exports ($m) *	Number of jobs
1,638	0.2	2,051	15,300

* FY2024

- Other products produced in the sector include bricks, pavers, and precast concrete components. Large scale railway, road and wind farm developments consume large quantities of cement, lime, and concrete products.
- At present the industry is highly trade exposed, and domestic demand is met through a mixture of onshore manufacture of clinker and imports from overseas suppliers.

Emissions profile

Scope 1 emissions (% whole-of-economy)	Safeguard facilities*	Safeguard facility emissions (% whole-of-economy)	Safeguard proportion of scope 1 subsector emissions
1.8%	7	1.2%	66%

* % of Australia's emissions, FY2023-24 (DCCEEW, 2025a; DISR, 2025)

- Emissions are primarily from integrated cement, clinker and lime facilities, with some emissions from brick manufacturing.

Most emissions associated with cement and concrete production are due to clinker and lime production from limestone, which is a high temperature (approximately 1,450°C) process that currently requires gas, coal, or other high carbon intensity fuels. The industry is also a large user of refuse-derived fuels, including biomass, which diverts emissions from landfill. In addition, the process is inherently carbon emitting regardless of heat source due to the chemical reaction (calcination) involving limestone (Cement Industry Federation, 2023).

Most opportunities to address scope 1 emissions in this sector rely on using less carbon intensive fuels for calcination and substituting some clinker with supplementary cementitious materials in cement and concrete production. Addressing the inherent process emissions from calcination of limestone remains a global challenge for the industry.

Several cement and concrete suppliers (including those manufacturing clinker in Australia) have started to offer lower-carbon products to the market, but some of these products require changes to the application of standards and specifications to enter more widespread use. As noted in the Built Environment Sector Plan, reducing cement and concrete use where possible, or specifying the use of lower-carbon cement and concrete, can greatly reduce the embodied carbon of new construction over time.

Fully net zero alternatives that can displace standard cement are yet to be discovered; however, there are lower emissions alternatives available such as circular economy opportunities to improve materials efficiencies, using supplementary cementitious materials (SCMs) and geopolymers as substitutes for clinker in concrete, and using renewable hydrogen for process heat in cement kilns. Bio-based SCMs may also play a role, as biological compounds can grant unique properties to cement from a sustainable source. Only certain cement types can be used in concrete under the relevant Australian standard for concrete to ensure it meets strength and other design criteria (Verein Deutscher Zementwerke, 2021). This is a key issue inhibiting the uptake of lower emission technologies in Australian cement production and use.

Chemicals and plastics manufacturing

Economic context

Number of businesses*	GVA (% of GDP) *	Exports ($m) *	Number of jobs
6,369	0.8	11,751	77,900

* FY2024

- Chemicals and plastics are critical enablers of almost every value chain across the economy, including mining, agriculture, construction, infrastructure, manufacturing, food, textiles, and healthcare. The chemicals and plastics industry includes base material manufacture, compounders, manufacturers, and recyclers.

Emissions profile

Scope 1 emissions (% whole-of-economy)*	Safeguard facilities	Safeguard facility emissions (% whole-of-economy)	Safeguard proportion of scope 1 subsector emissions
2.0%	11	1%	51%

* % of Australia's emissions, FY2023-24 (DCCEEW, 2025a; DISR, 2025)

- Emissions primarily come from ammonia production, process heat generation and nitric acid production with smaller portions from onsite electricity generation and the production of titanium dioxide.

Chemicals and plastics processes rely on fossil fuels as both an energy source and feedstock. About half the scope 1 emissions from chemical manufacturing are from the use of natural gas. Two-thirds of this are from using natural gas as an input into the production of other chemicals such as ammonia and nitric acid for use in explosives and fertilisers.

Opportunities for decarbonisation include integrating renewables and affordable renewable hydrogen and carbon feedstock at scale, efficiencies, and industrial symbiosis through industrial precincts.

Currently, hydrogen is produced and used within the chemicals and plastics manufacturing sector, for example as a precursor to ammonia (for explosives and fertilisers), and in plastics materials and solvents. Chemicals manufacturers making hydrogen and ammonia for industrial purposes are well placed to produce them to use as energy carriers in the energy sector, for transportation fuels, and for export.

Virgin plastic production is an inherently carbon intensive process given the use of fossil fuels as feedstock and the energy used to create plastics. Australia is well placed to increase plastics circularity through product design improvements, greater use of recycled and bio-feedstocks, and improved and advanced recycling technologies. This will help the sector to reduce the reliance on virgin fossil fuel plastic resins in the future.

Opportunities to produce lower emission products include:

- Coated fertilisers from ammonia that result in lower emissions when used in agriculture
- Insulation and other energy efficiency solutions for homes and the built environment
- Lightweight, energy-saving materials for vehicles and transport such as plastic panelling, foams and carbon fibre materials (ICCA, 2020).

Food and beverage manufacturing

Economic context

Number of businesses*	GVA (% of GDP) *	Exports ($m) *	Number of jobs
15,414	1.3	38,345	235,100

* FY2024

- Australia is a net exporter of food products and has a global reputation for safe, clean food. The food and beverages manufacturing sector is diverse, itself encompassing multiple industries, and has many SMEs.
- Meat processing, grain milling, and cereal product manufacturing are the 3 highest emitting industries within this subsector and account for 64% of its total emissions.

Emissions profile

Scope 1 emissions (% whole-of-economy)	Safeguard facilities*	Safeguard facility emissions (% whole-of-economy)	Safeguard proportion of scope 1 subsector emissions
0.8%	1	0.1%	11%

* % of Australia's emissions, FY2023-24 (DCCEEW, 2025a; DISR, 2025)

- Emissions are spread across a wide variety of businesses. Emissions are largely from using fossil fuel for low to medium temperature processes, and from synthetic greenhouse gas refrigerants.

Due to the perishability of many food and beverage products, and food safety requirements, the sector is reliant on maintaining robust cold-chain and refrigeration systems for processing, storage, and transport of foodstuffs. This highlights the importance of energy and transport reliability and the security that grid power provides.

Sustainability is already a significant focus for food and beverage businesses and consumers, with a decarbonised food supply chain expected to be a competitive necessity in the future for both export and domestic suppliers. Major supermarket retailers already require food and beverage suppliers to demonstrate decarbonisation commitments in line with retailers' own aspirational net zero targets.

Opportunities to decarbonise include optimising energy consumption, process heat generation and recapture, reuse of materials (including waste-to-energy), upgrading to more energy efficient equipment and processes, and electrification. Alternative technologies are currently available to address many of these processes. Synthetic greenhouse gas refrigerants used for process heating and cooling can be replaced with lower global warming potential alternatives to reduce scope 1 emissions. Biogas energy is an increasingly important energy source and an alternative to grid gas in regions with reliable waste streams. Sustained high-energy input costs will drive uptake of alternative energy technologies and electrification.

The decarbonisation challenges for the food and beverages subsector are primarily economic, including barriers to investment, market demand, and tight margins. The subsector is also slow to share data on successful transition projects to quantify results and awareness of technology solutions, to build broader industry confidence.

Achieving decarbonisation requires greater awareness across the sector and demonstration of available low-emissions technologies. Almost 90% of businesses within the food and beverages subsector are SMEs that are not captured within existing emissions reporting measures such as the National Greenhouse and Energy Reporting scheme (NGERs).

Food waste accounts for 3% of Australia's emissions and costs our economy $36.6 billion each year. The amount of land we use to grow wasted food covers over 25 million hectares – a landmass bigger than the state of Victoria. Working across the supply chain to minimise food wastage will also significantly reduce emissions. (DCCEEW, 2024b).

Iron and steel manufacturing

Economic context

Number of businesses*	GVA (% of GDP) *	Exports ($m) *	Number of jobs
16,745	0.7	4,899	98,200

* FY2024

- Iron and steel manufacturing provides key inputs for the construction, defence, transport, infrastructure, and renewables industries, and is important for sovereign capability. It is a trade exposed industry and faces competition from Asian steelmakers.

Emissions profile

Scope 1 emissions (% whole-of-economy)	Safeguard facilities*	Safeguard facility emissions (% whole-of-economy)	Safeguard proportion of scope 1 subsector emissions
2.1%	6	1.7%	82%

* % of Australia's emissions, FY2023-24 (DCCEEW, 2025a; DISR, 2025)

- Emissions are primarily from integrated iron and steel works using iron ore and coking coal (~70% of emissions) to make primary steel, and electric furnaces using electricity from the grid and scrap steel.

Primary (or virgin) iron and steel are currently made in Australia through an integrated process, from Australian iron ore (hematite and magnetite ores) and various sources of metallurgical (coking) coal. The first stage of the process uses a BF for ironmaking, reaching over (>1,200°C), and the second stage converts the hot liquid iron into steel through a basic oxygen furnace (BOF) (>1,500°C). Australian operators also use smaller scale EAFs, primarily for scrap recycling. Decarbonising primary iron and steelmaking requires alternative heat processes and material inputs, such as renewable hydrogen, to provide heat and the chemistry required to make iron and steel (Australian Industry Energy Transitions Initiative, 2023).

There are 2 main types of Australian iron ore used for steelmaking: hematite and magnetite.

- Hematite iron ore, also known as Pilbara iron ore, is well suited to conventional BF-BOF steelmaking which can easily remove impurities and is overwhelmingly Australia's main iron ore export. Hematite ore is currently used at BlueScope's Port Kembla Steelworks. Improvement in the processes for using hematite in decarbonisation technologies requires further research.
- Magnetite iron ore is better suited to decarbonisation technologies. This is due to its magnetitic qualities, which enable it to be more easily concentrated, lifting its iron content to the level required for use in decarbonisation technology pathways such as DRI. Production of iron from magnetite is well proven and underway in Australia, notably through the Port Latta plant in Tasmania (Grange Resources, 2023). Technology pathways to concentrate magnetite for use in conventional steelmaking are also suitable for zero emission steelmaking pathways.

Near zero emissions primary steel production has been proven internationally in Sweden, achieved through significant public and private investment in the research, development, and demonstration of its HYBRIT technology (Hybrit, 2023). Following this success, Stegra in Sweden is preparing to produce green steel with about 95% less greenhouse gas emissions than conventionally produced steel (Stegra, 2025). The quality of primary steel made using decarbonisation pathways is the same as that from conventional technologies. Industry is investigating the Australian applicability of HYBRIT technology, H2 Green Steel, and similar processes.

Steelmaking using scrap steel does not require high temperatures or carbon-based inputs like coking coal or natural gas, as the iron has already been turned into steel, making it an attractive input that can lower costs. For every tonne of scrap used for steel production, 1.5 tonnes of carbon dioxide emissions can be avoided (World Steel Association, 2021). Increasing the use of scrap steel offers a pathway for immediate reductions in emissions. Scrap is the main input to Australia's electric arc furnaces to produce steel, which can be powered by 100% firmed renewable electricity, when combined with energy storage. About 26% of Australian steel is produced via the EAF process (Australian Steel Institute, 2023).

Steel mills typically source domestic scrap metal within a 200km radius of the mill due to high transport costs (KPMG, 2023). The majority of Australia's scrap metal processing capacity is far from where the materials will be received, though supply chains for material management are developing in response (CSIRO, 2024). Opportunities for Australia to further use scrap steel will be explored, noting there can be some limitations due to the presence of other metals in the scrap. For example, copper cannot be readily separated and its presence in scrap affects the quality of steel produced (Nicholas & Basirat, 2022).

Australian research is underway through:

- HILT CRC with key industry stakeholders to explore suitable technology pathways
- ARENA funding to Calix to support demonstration of its Zero Emissions Steel Technology – ZESTY
- BlueScope, BHP and Rio Tinto partnership to produce green iron from Pilbara ores
- CSIRO pre-feasibility study around a common user pilot facility for low emissions ironmaking.

Transitioning to net zero is fundamentally disrupting the global iron and steel industry. Many decarbonisation technologies would decouple iron making from steel making processes. This could see ironmaking becoming positioned close to locations that are rich in renewables resources and able to competitively produce renewable hydrogen, with decarbonised iron exported to steel making locations.

Manufacturing and additional industries

Economic context

Number of businesses*	GVA (% of GDP) *	Exports ($m) *	Number of jobs
72,207	4.1	71,756	598,600

* FY2024

- Manufacturing and additional industries includes glass manufacturing, battery production, clean technologies, data centres and other digital technologies, and excludes industries captured under the other 8 subsectors in this document.

Emissions profile

Scope 1 emissions (% whole-of-economy)	Safeguard facilities*	Safeguard facility emissions (% whole-of-economy)	Safeguard proportion of scope 1 subsector emissions
0.6%	3	0.1%	34%

* % of Australia's emissions, FY2023-24 (DCCEEW, 2025a; DISR, 2025)

- Scope 1 emissions are concentrated within large glass and magnesia businesses.

Glass manufacturing

Glass making is the primary source of emissions within the manufacturing and additional industries subsector, due to its reliance on high heat processes (>1,600°C) requiring the use of fossil fuels to melt sand into glass. No alternative low emissions technologies or alternative heat sources have been identified to date. While the use of hydrogen is being explored, this is at very early stages. It is not yet clear that hydrogen will provide the relevant chemical properties to produce the quality of glass products needed by industry.

Glass is also a key input into improving energy efficiency and thermal comfort in buildings, key to the Built Environment Sector Plan. Maintaining sovereign capabilities in glass manufacturing is important for security of supply to the building and construction sector.

Battery manufacturing and clean energy technologies

Demand for products and materials to enable the economy to transition to net zero is expected to grow. Australian manufacturing is well placed to provide the infrastructure, equipment and technology needed for this transition. This includes solar panels, on and offshore wind, lower-carbon construction, and energy storage systems and electrified heavy machinery.

On 28 March 2024, the Australian Government announced it will invest $1 billion in the new Solar Sunshot program to accelerate the development of Australia's solar manufacturing industry, catalyse clean energy industries, and help Australia connect to new global supply chains (ARENA, 2024).

Batteries are a critical technology underpinning Australia's long-term energy security and pathway to net zero. Australian made batteries can help meet long-term demand for stationary energy storage

and support the Australian Government's decarbonisation commitments. The global battery demand is expected to increase by 18-fold over the next decade (Accenture, 2023). Strengthening Australia's battery manufacturing capabilities would support firming electricity supply for those industries requiring reliable supply.

Data centres

Australia has over 200 data centres, primarily located in and around the major capital cities Sydney, Melbourne, Brisbane, Perth, Canberra and Adelaide (Data Centre Map, 2024). Data Centres are large electricity and energy users, predominantly required for cooling (Noble, Atherton, & Berry, 2023) and to ensure uninterrupted electricity supply of their operations, that are used to support a range of digital technologies used across the economy and by households.

In 2022–23, diesel generators (60.5%) and refrigerant gases (39.4%) were the main source of scope 1 emissions from data centres. Diesel generators are typically used intermittently, to ensure their uninterruptable electricity supply needs can be met. Most emissions from data centres are scope 2 from electricity use from the grid.

Demand for data centres is expected to grow due to increasing use of digital technologies such as Artificial Intelligence, cloud services, the internet of things and blockchain. AEMO projects that data centre electricity demand will rise from a current 4 TWh to around 12 TWh in 2029–30.

Reducing emissions will be driven by improving efficiency of its cooling systems and electricity use, and low emission substitutes for backup electricity supply.

Data centre owners and operators are increasingly employing innovative technologies and design elements themselves to reduce emissions and maximise energy efficiency, particularly in newly built centres. There are significant opportunities to improve energy efficiency and reduce emissions particularly in existing older data centres.

Rooftop solar photovoltaic (PV) panel recycling

With one of the highest rates of rooftop solar PV users in the world, there will be a rapid growth in PV waste in Australia in the coming years when systems come to end of life or require replacement. Emissions reductions can be achieved through the efficient collection, transportation and treatment of PV waste, as well as the recovery of critical minerals to be reused in manufacturing new PV panels.

The main barriers to solar panel recycling are costs, purity of extracted materials, environmental impacts of recycling processes and access to information on solar panel recycling facilities.

A 2024 *Australian Centre of Advanced Photovoltaics* (ACAP) study has suggested that cumulative PV waste in Australia could reach 2–3 Mt by 2050. End-of-life solar panels are a source of valuable critical materials such as silver, copper, and high purity silicon, glass, and aluminium which can be utilised in the manufacture of new modules. The ACAP study suggests that in 5 years, end-of-life silver and aluminium from PV panels could supply 30% of future PV demand, 50% in 15 years, escalating to 100% in 25 years. The appropriate recycling and reuse of PV waste could significantly reduce emissions through lowering demand for new raw materials. The Australian Government and industry groups have been working on a number of proposals to enhance recycling and product stewardship for solar panels.

Other metals refining and smelting

Economic context

Number of businesses*	GVA (% of GDP) *	Exports ($m) *	Number of jobs
296	0.1	43,600	13,100

* FY2024

- These metals are key inputs in the development and manufacture of renewable energy infrastructure, particularly for battery storge, hydrogen electrolysers and solar panels.

Emissions profile

Scope 1 emissions (% whole-of-economy)	Safeguard facilities*	Safeguard facility emissions (% whole-of-economy)	Safeguard proportion of scope 1 subsector emissions
0.1%	3	0.1%	91%

* % of Australia's emissions, FY2023-24 (DISR, 2025; DCCEEW, 2025b) Note: Safeguard facility emissions for Metal Smelting and Refining are calculated as a percentage of NGER emissions.

- Emissions are concentrated within a small number of large businesses. Remaining businesses with the sector are mostly fabrication operations.

The metals refining and smelting sector uses multiple processing operations and techniques, metals captured under this subsector for the Industry Sector Plan includes copper, zinc, lead, gold and silver. These can differ even within a metal type and will require process specific decarbonisation solutions. Reducing emissions from metals refining and smelting will rely on the development of alternative high heat processes and the electrification of existing facilities. Given that some of facilities are aged, there is an opportunity for renewed investment to encourage the adoption of new approaches towards net zero production.

R&D is needed to explore alternative methods and processed to displace or reduce carbon-based inputs where possible, as reactants for metals refining and smelting.

Pulp, paper and paperboard manufacturing

Economic context

Number of businesses*	GVA (% of GDP) *	Exports ($m) *	Number of jobs
660	0.1	1,143	18,500

* FY2024

- The industry provides the materials needed for packaging, office supplies, and many household products.
- Australia's pulp and paper industry is characterised by price volatility set by global markets, making it significantly trade exposed with thin cost margins.

Emissions profile

Scope 1 emissions (% whole-of-economy)	Safeguard facilities*	Safeguard facility emissions (% whole-of-economy)	Safeguard proportion of scope 1 subsector emissions
0.2%	3	0.1%	53%

* % of Australia's emissions, FY2023-24 (DCCEEW, 2025a; DISR, 2025)

- Heating and drying processes account for most emissions in pulp and paper manufacturing.
- Facilities with emissions below the NGERs threshold include stationery and printing businesses.

Digitisation of the economy has resulted in slowing demand for paper products from key markets (i.e., newspaper and print media), which has been somewhat offset by rising demand from online retailers requiring paperboard packaging products. Upstream, the sector is also affected by supply challenges, such as lack of plantation investment and state bans on native timber harvesting.

The industry is energy and water intensive, using low and medium heat processes for drying pulp into paper and paperboard products. According to the IEA (IEA, 2023b), drying accounts for 70% of the energy use in the sector. A key challenge is gaining access to available capital to retrofit existing systems, and to affordable renewable electricity at scale.

Pulp and paper decarbonisation will rely on optimising energy consumption, using bioenergy, adopting alternative process heat technologies, electrification, and more efficiency in waste and recycling management across the supply chain. Many of these technologies are currently commercially available.

Waste and resource recovery

Economic context

Number of businesses*	GVA (% of GDP) *	Exports ($m) *	Number of jobs
5,745	0.3	n/a	47,800

* FY2024

- The sector is dominated by large companies that provide collection services and operate (and often own) waste and recycling infrastructure. It includes both public and private operators.
- The sector is currently experiencing rapid growth in recycling and processing operation in Australia supported through recent state and federal government funding programs.

Emissions profile

Scope 1 emissions (% whole-of-economy)	Safeguard facilities*	Safeguard facility emissions (% whole-of-economy)	Safeguard proportion of scope 1 subsector emissions
2.8%	3	0.1%	3%

* % of Australia's emissions, FY2023-24 (DCCEEW, 2025a; DISR, 2025)

- Emissions from waste and resource recovery are primarily from organic matter going to landfill, which escape as fugitive emissions. Facilities with emissions below the NGERs threshold include regional and small landfills. Reporting on landfill managed by local government is also not mandatory.

The waste and resource recovery sector is a key enabler for the circular economy and provides an essential service to the Australian community. The sector is responsible for collecting, transporting, recycling, treating, and disposing of materials. Businesses are diverse in size and location and often operate with thin margins. Service providers have little control over inputs, and there is very little tolerance for disruption to the essential services these businesses provide. These features complicate the sector's net zero transition.

Various technologies are available to avoid, reduce and capture emissions from the waste and resource recovery sector. As most of the sector's emissions come from decomposing organics in landfills, approaches that divert organics for alternative treatments will have a high impact.

Importantly, our net zero transition provides significant opportunities to create new markets for waste and resource recovery companies. Consumer preferences for more sustainable products, including products that can be repaired, reused, repurposed and recycled, mean end of life solutions for products are becoming increasingly important.

There is an opportunity to divert materials to higher value products, such as bioenergy and biogas, as well as reusing and recycling construction materials, in partnership with the Transport and Built Environment Sector Plans. The ACCU scheme plays an important role incentivising emission reductions in this sector.